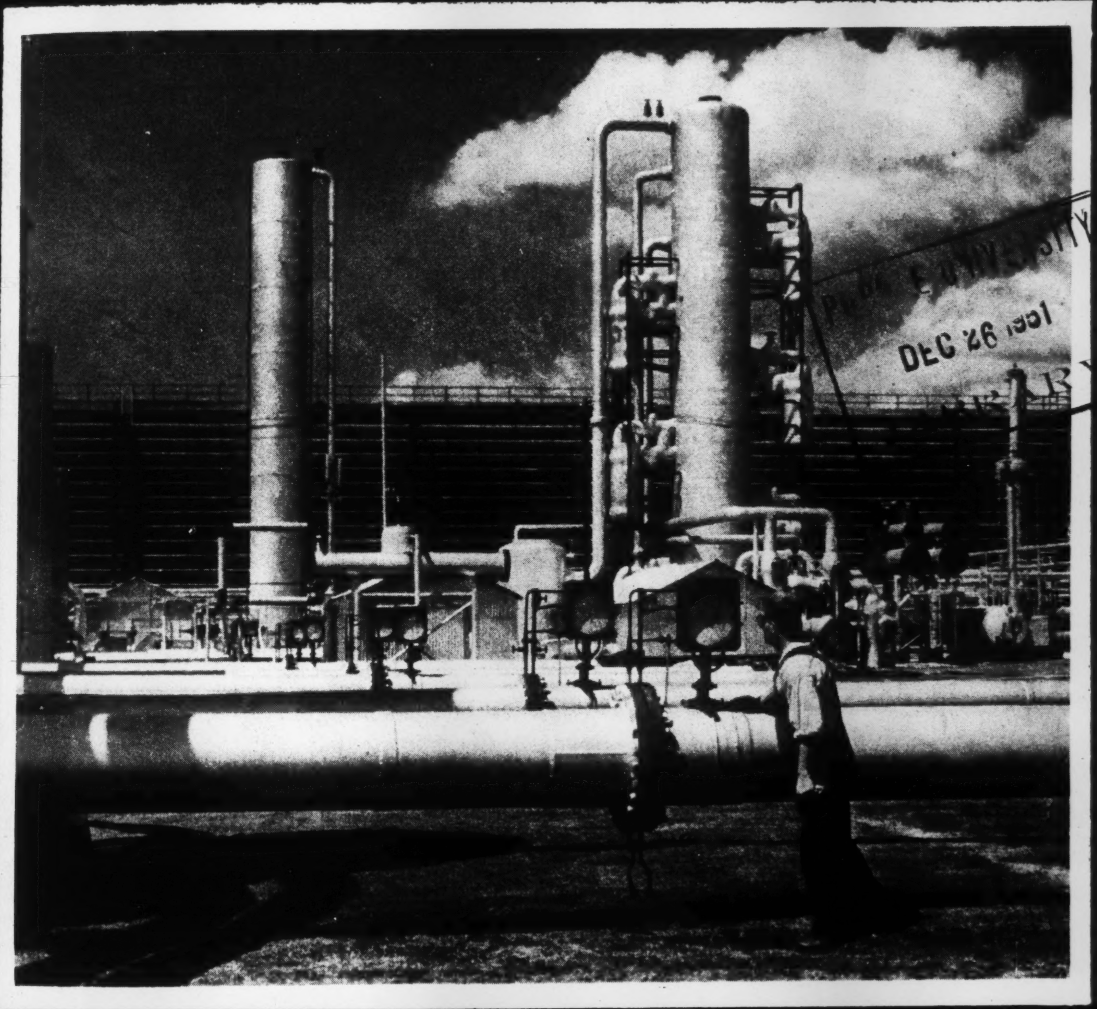
Instruments

THE MAGAZINE of MEASUREMENT and CONTROL

Vol. 24 DECEMBER 1951 No. 12

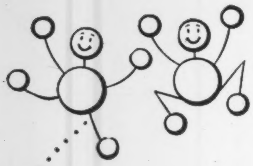
INCLUDING THE Journal of the Instrument Society of America
AND THE Journal of the Southern California Meter Association

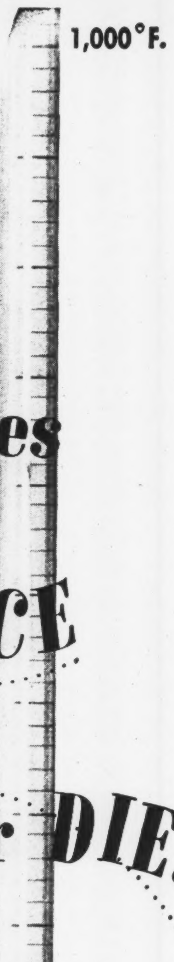


DEC 26 1951

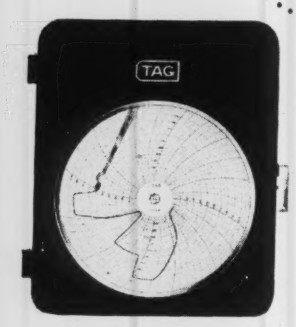
Emco orifice meters in the Gladewater, Texas Plant of the Warren Petroleum Corporation.

(Courtesy Rockwell Manufacturing Co.)





Where molecules DANCE or DIE...



TAGLIABUE RECORDERS Chart *Changing* Temperatures

From the mad molecular dance at a thousand degrees to the killing cold of three hundred below, TAGliabue Recorders faithfully chart changing temperatures for future reference. Whether your requirements are for a sensitive instrument spanning but a few degrees . . . for a model built for one temperature extreme or the other . . . or for a conventional instrument that's adaptable to myriad industrial applications—you will find a TAG Temperature Recorder that meets your every need.

And in all TAG Recorders you can count on the same simple, sound design . . . the same sturdy construction . . . that have long kept TAGliabue leaders in temperature instrumentation.

Feel free to call on your TAG Representative for assistance in applying these modern instruments to your processes.

TAG TAGLIABUE INSTRUMENTS DIVISION
Weston Electrical Instrument Corporation
618 Frelinghuysen Avenue, Newark 5, New Jersey

See the line of TAGliabue Instruments in Booth 16 at the Chicago Canning Show

Automatic Retort Control Regulates Process Timing

Any semi-automatic air operated retort control system can be made fully automatic with the Process Control Timer developed by TAGliabue Instruments Div., Dept. 67, Weston Electrical Instrument Corp., Newark 5, N. J. Pressure, heating and cooling cycles are easily regulated with this uncomplicated device.

The instrument rigidly controls temperature and pressure and their duration, and automatically operates all water, air and steam valves. The entire process is set in motion by a push button in a corner of the control panel.

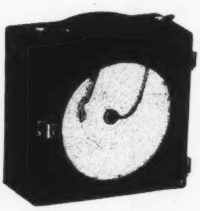
Self-Operating Controllers Hold Precise Temperatures

Temperatures between the limits of 20 and 300°F. are accurately maintained by the line of Self-Operating Controllers manufactured by TAGliabue Instruments Div., Dept. 67, Weston Electrical Instrument Corp., Newark 5, N. J. These controllers are entirely self-contained, requiring no connection to any air or electrical power supply.

Available in styles for use on steam, hot water or refrigerant lines, TAG Self-Operating Controllers continuously adjust the supply of heating or cooling medium to maintain constant temperature despite changing thermal conditions. Typical applications include water heaters, tanks, retorts, washers, driers and pasteurizers.

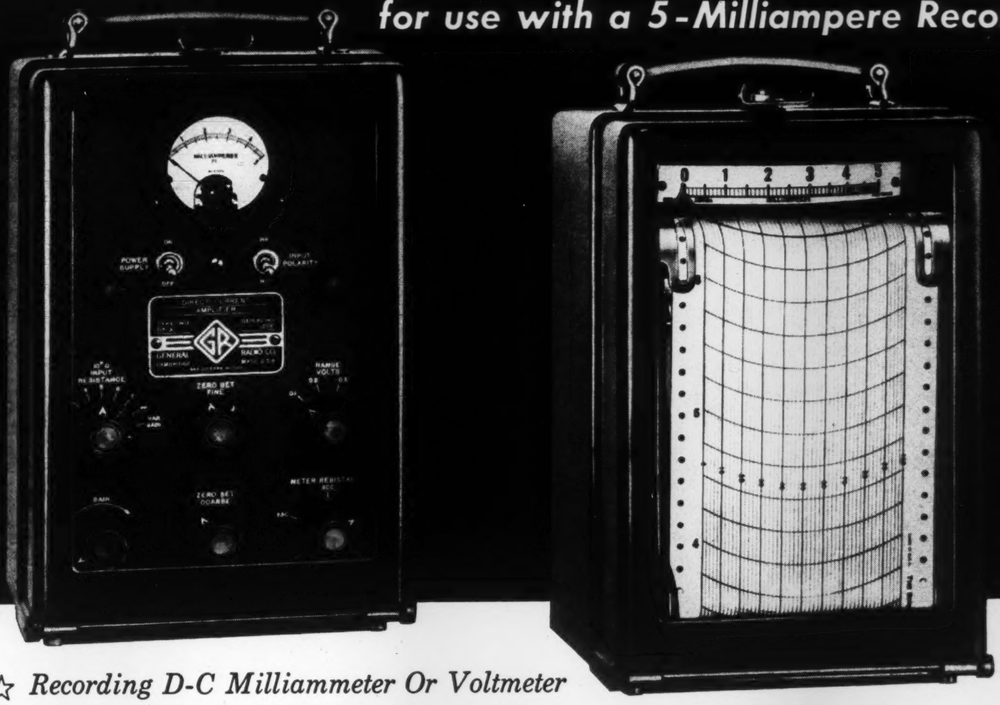
Temperatures in Mobile Units Charted by Miniature Recorder

A continuous record of temperatures in heated, refrigerated or air conditioned spaces is provided by a miniature self-contained recording thermometer developed by TAGliabue Instruments Div., Dept. 67, Weston Electrical Instrument Corp., Newark 5, N. J. This new instrument, known as the TAG Model 8475 Miniature Recorder, requires no connection to any power supply, yet charts temperatures for as long as seven days without attention. Its unique design eliminates need for shockproof mounting. Temperatures as low as —30°F. or as high as +220°F. can be recorded. The instrument measures 5¾" x 5¾" x 4¼", and weighs 3½ pounds.



A DIRECT-CURRENT AMPLIFIER

for use with a 5-Milliampere Recorder



☆ *Recording D-C Milliammeter Or Voltmeter*

☆ *Measuring emf of Electro-chemical Cells* ☆ *Recording Sound and Vibration*

☆ *Recording Variations in Insulation Resistance during Dehydration*

☆ *Recording Frequency and Modulation Levels of Broadcast Transmitters*

☆ *Operation from Resistance Thermometers, Photo Cells, Strain Gauges*

☆ *Process Control* ☆ *Measurements in Physical and Chemical Laboratories*

The Type 715-AE D-C Amplifier was designed particularly for operation with the standard Esterline-Angus Company 5-milliampere Recorder for applications similar to those suggested above.

This amplifier has high gain and very good stability of calibration. It has four calibrated ranges each giving 5 ma linear output in the recorder circuit of 1000 ohms, for input voltages of 0.1, 0.2, 0.5 and 1.0 volt across the input terminals with either polarity.

Type 715-AE *D-C Amplifier (Illustrated) in metal case to match Esterline-Angus Recorder (Recorder not included)* **$365.00**
Type 715-AM *D-C Amplifier in Walnut case* **$320.00**

Its calibration accuracy as a voltmeter is approximately 1% of full-scale. A number of input resistances are selected by a switch for resistances between 100 ohms and 10 megohms, so that the amplifier not only has an adjustable input resistance but also can be used as a calibrated millivoltmeter or microammeter.

Over room conditions normally encountered, operation and stability are independent of ambient temperature or changes in relative humidity.

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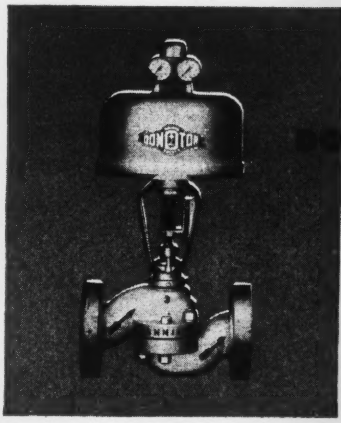

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Precise control of hard-to-handle fluids. Powerful piston action combined with sensitivity and stability. Integral null type positioner eliminates external attachments.

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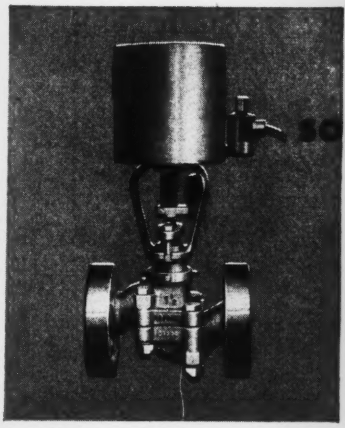

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Piston actuated by pressure regulated by 3- or 4-way solenoid pilot valve. Powerful valve action by remote control. Fast shockless action in all types of service.

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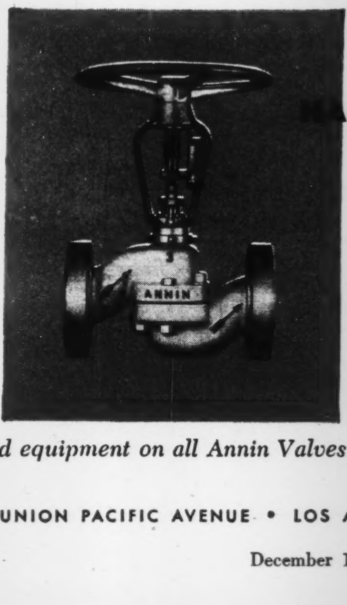
Superior performance at temperatures from −300° F to 1000° F and at pressures up to 3000 psi, plus lowered maintenance and inventory costs make ANNIN Valves first choice among valve users everywhere. It will pay you—in superior performance and lower operating costs—to investigate. Send today for Bulletin.



HANDWHEEL

Valuable companion in shut-off service to the Domotor under same operating ranges. Interchangeable characterized trims make it valuable for batch and non-continuous fluid processing control.

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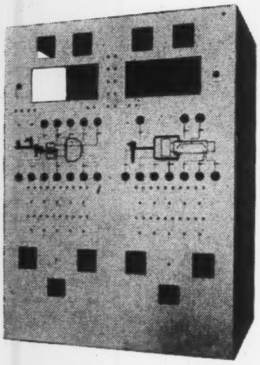

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Instruments
THE MAGAZINE OF
Measurement and Control

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LEWIS

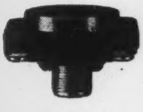
RESISTANCE THERMOMETER AND ACCESSORIES

-60
-50
-40
-30
-20
-10
0
10
20
30
40
CENTIGRADE
ON
CH.
OFF

The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

ACCESSORIES — RESISTANCE BULBS AND SWITCHES

Lewis Selector Switches have been used for years in automotive test work as well as in permanent installations. Simple, sturdy construction plus finest materials combine to give long service.



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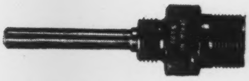
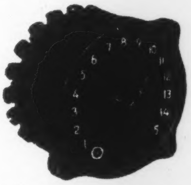
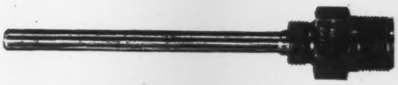
2" SIZE TO 4 POINTS



THREADED "AN" TYPE

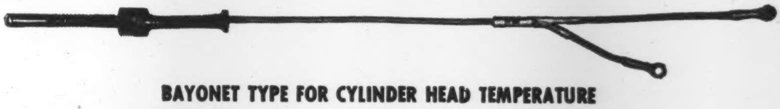


3" SIZE TO 20 POINTS



THREADED "AN" TYPE

4" SIZE TO 28 POINTS



BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

Lewis Resistance Bulbs are adaptable for use with the 62RT4F Resistance Thermometer or with standard aircraft panel indicators. Special purpose bulbs with stem variations or for high temperature applications are available.

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Specialists in Electrical Temperature Measurements

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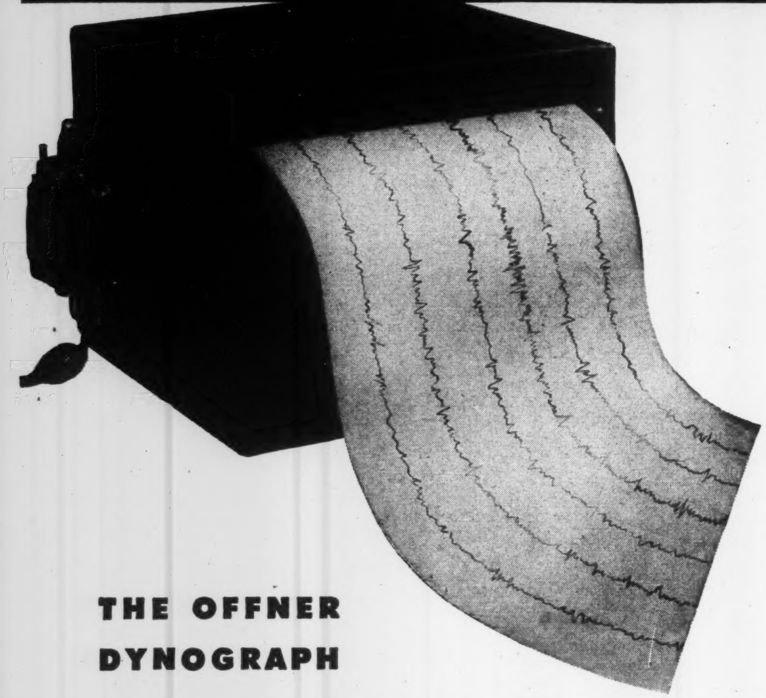
drift-free d.c. recording



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and Control

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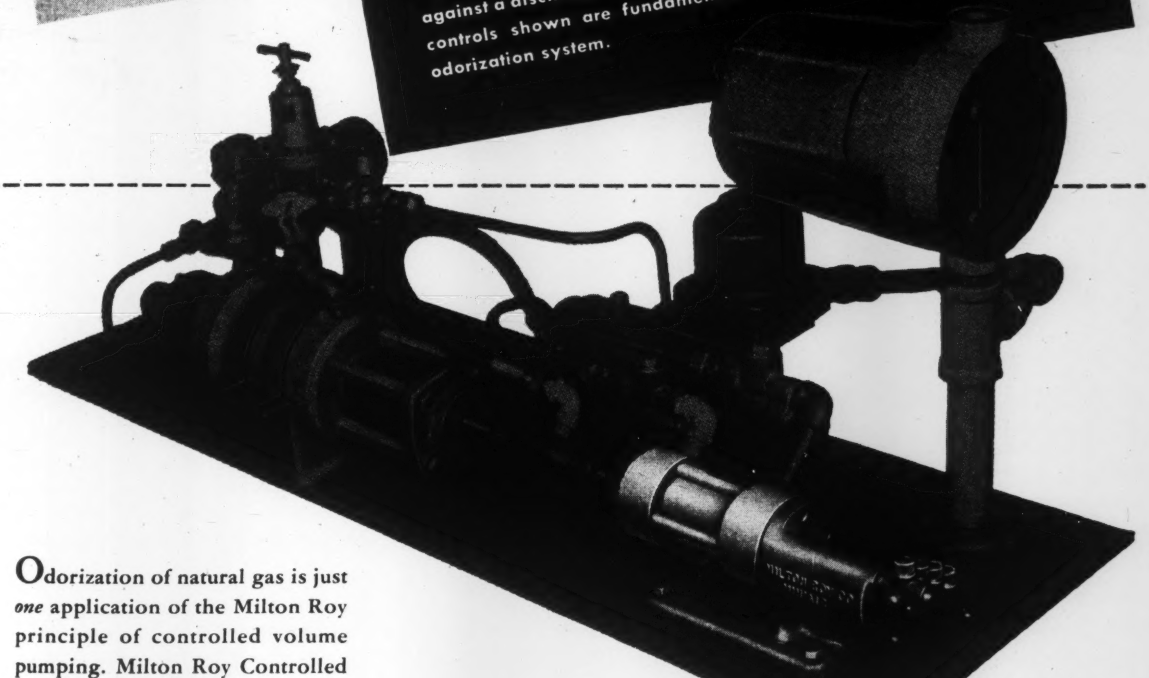

Odorization of natural gas is just *one* application of the Milton Roy principle of controlled volume pumping. Milton Roy Controlled Volume Pumps are widely used elsewhere in the petroleum industry—for pumping distillates, solvents, furfural, liquefied petroleum gases, tars, sludges, asphalts, petrolatum. They are used for the addition of inhibitors, controlled catalyst make-up, and for other processing techniques.

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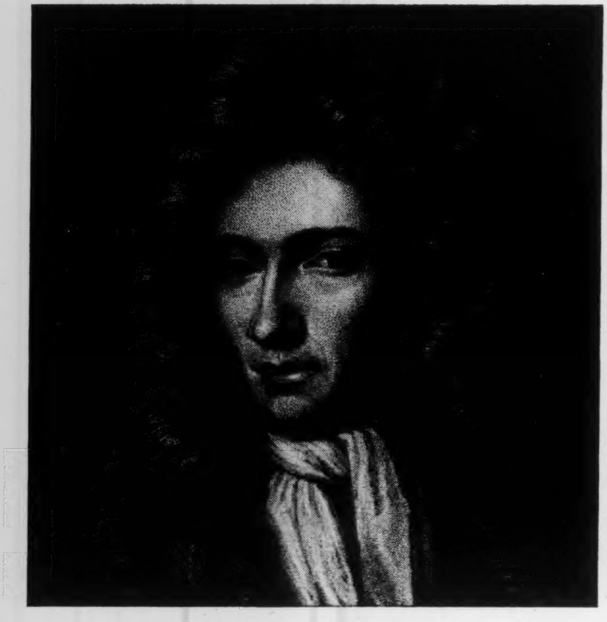

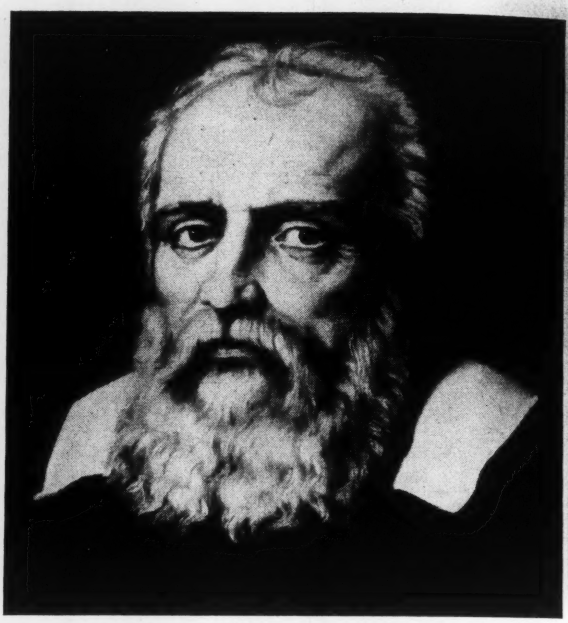

How many do

Whether you recognize the first three faces or not, we think you'll know the fourth one. There are thousands of these Taylor Fulscope* Controllers in service today, in almost every process industry from chemicals to milk, from petroleum to plastics.

A Taylor FULSCOPE Controller is a rugged, dependable air-operated instrument for control of temperature, pressure, flow, liquid level, density, load and humidity. It was the first controller on the market with completely interchangeable unit construction.

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*Reg. Trade-Mark

The six standard types of FULSCOPE Controllers fit almost any processing need:

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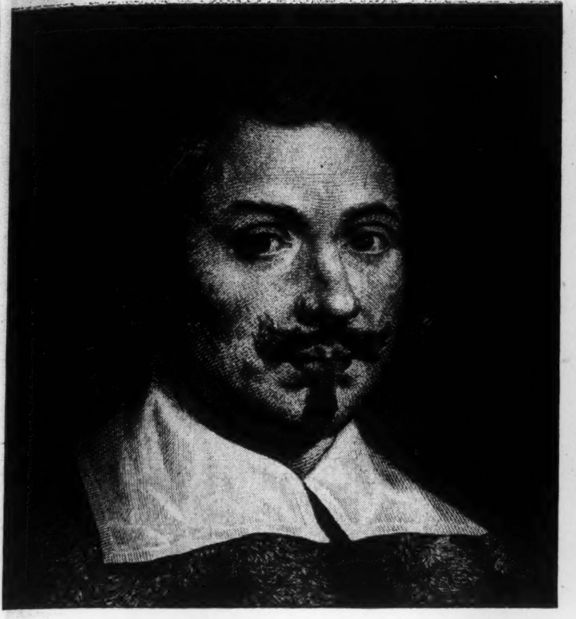
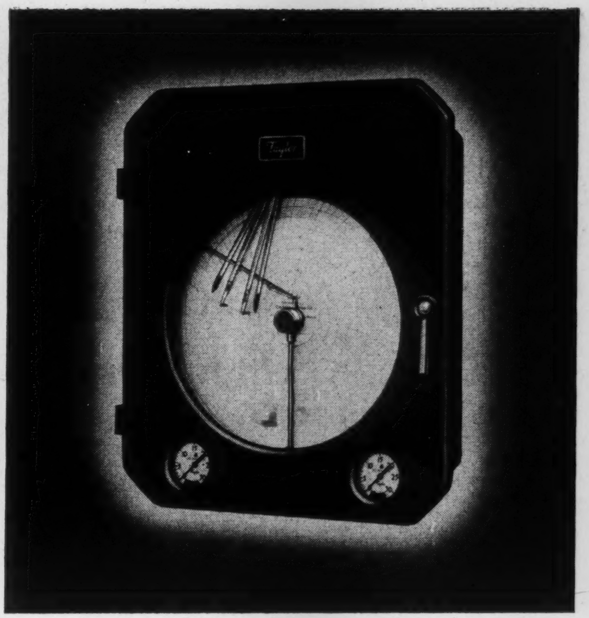
2. For throttling control on similar applications, you need *Adjustable Limited Range Sensitivity.*

3. Throttling control where you have a wide range of time lags and capacities, infrequent or negligible load changes, calls for *Full Range Adjustable Sensitivity.*

4. Precision control under a wide range of time lags and capacities, with gradual, sustained load changes, calls for *Adjustable Sensitivity with Automatic Reset.*

5: Where there are momentary disturbances, but no sustained load changes, get *Adjustable Sensitivity with Pre-Act.*





you recognize?

6. To meet almost any control problem, get the Fulscope Controller with all three control effects: *Adjustable Sensitivity*, *Pre-Act* and *Automatic Reset*. It gives precision control on applications with a wide range of time lags and capacities, and sudden, sustained load changes.

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Still wondering who the men are? All are founding fathers of the instrument industry. First on the left above is Torricelli, who made the first barometer. Next is Galileo, maker of the first thermometer, and then comes Boyle, who discovered Boyle's Law. The face on the right, of course, is the famous Taylor Fulscope Controller. It is found in practically every process industry.

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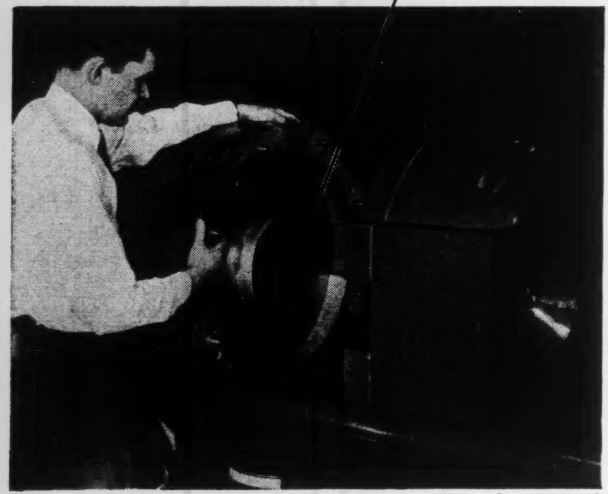

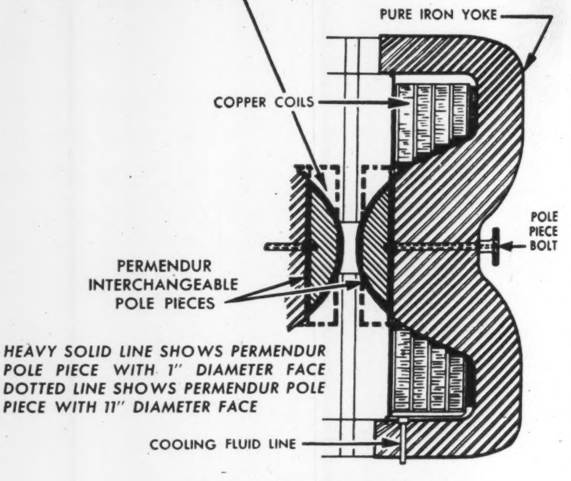
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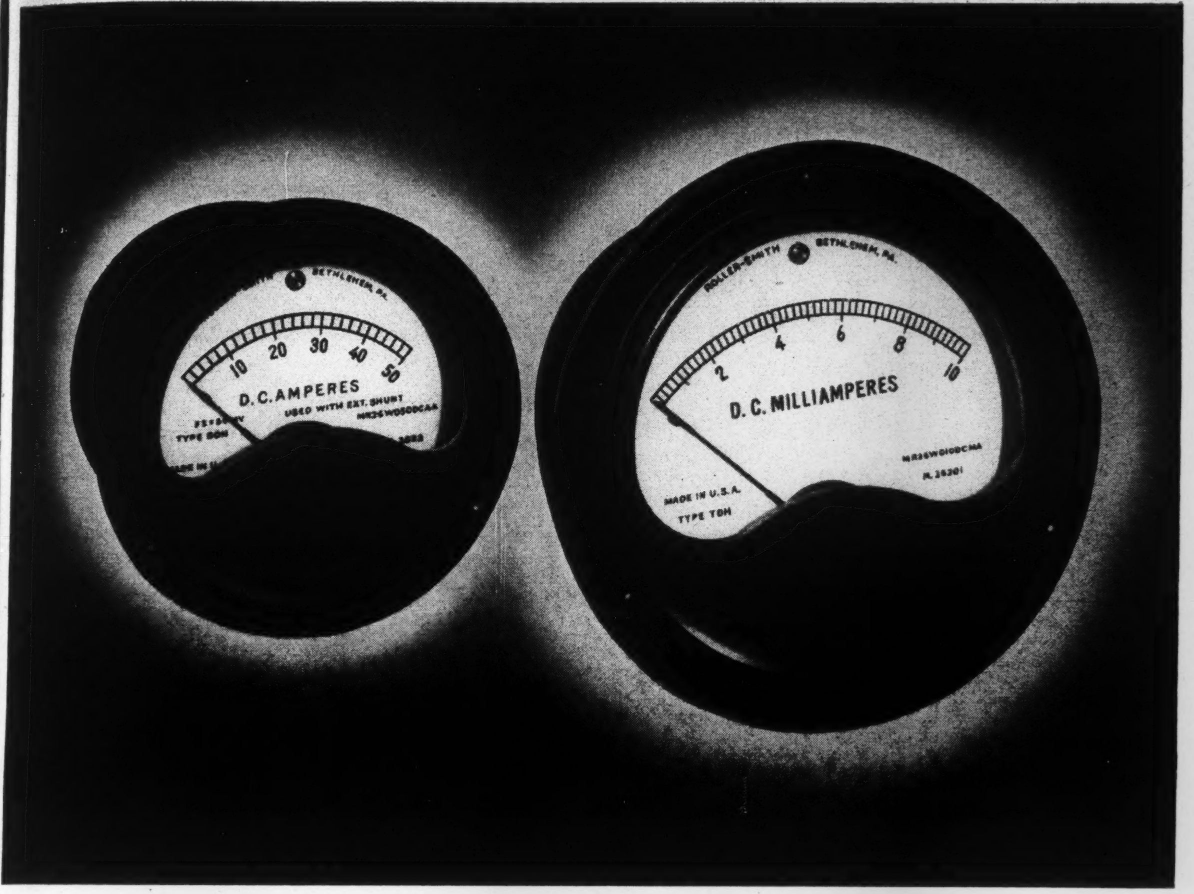
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In addition to *Ruggedized* instruments, a complete line of hermetically sealed and unsealed types in conformance with Government specifications are available.

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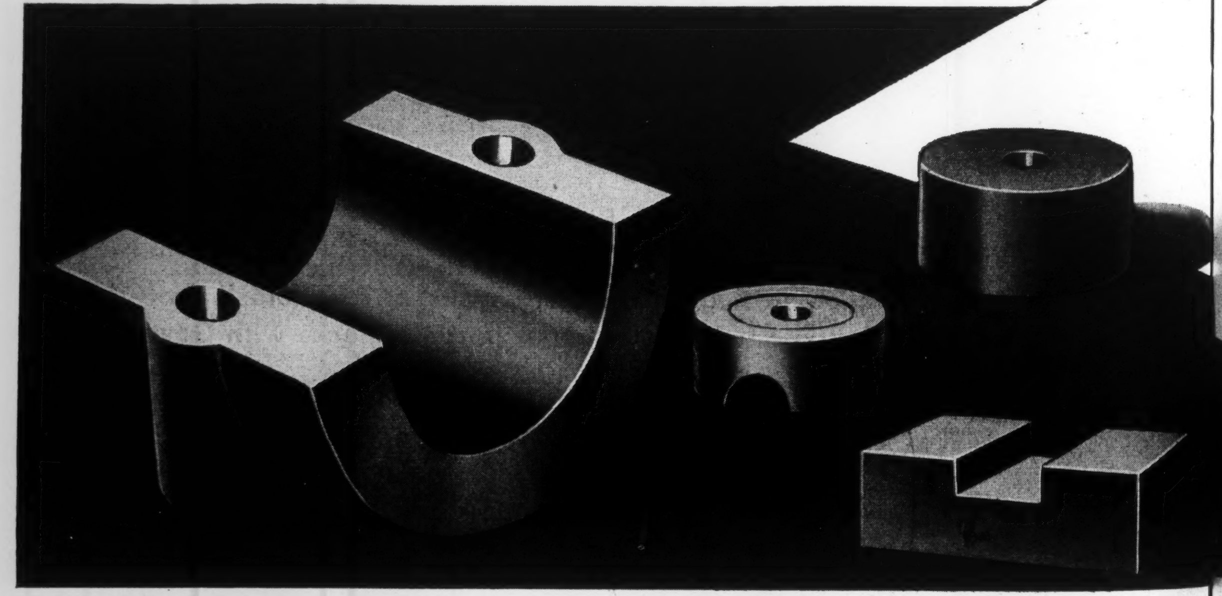
Built Righ

Carboloy Alnico permanent magnets



Delivered Right on Time

and with

Energy-Potential Right

Do you need permanent magnets . . . to improve a meter, motor, instrument or other essential product? To modernize a chuck or holding assembly? Or for one of the many communication applications?

Then, whether cast or sintered . . . specially designed or from standard stock . . . in blank, assemblies or subassemblies, you'll find that Carboloy Alnico permanent magnets *are right* for you.

For Carboloy magnet engineers, *backed by the very men who first developed permanent magnets*, expertly *design* magnets to your exact specifications . . . or select the proper magnet from among the many thousands already designed and in stock.

Strict Carboloy quality controls and expansive facilities assure you *better-built* magnets, too. Each tops in quality . . . the absolute in uniformity . . . *and each guaranteed to meet or surpass the industry's external energy minimum.* And, once your magnet order has been accepted and scheduled, it is delivered right on the dot, as promised.

If you need help in a hurry on permanent magnets, contact Carboloy magnet engineers now. Turn your problem over to them. Send specifications, or write for Standard Stock Catalog PM-100.

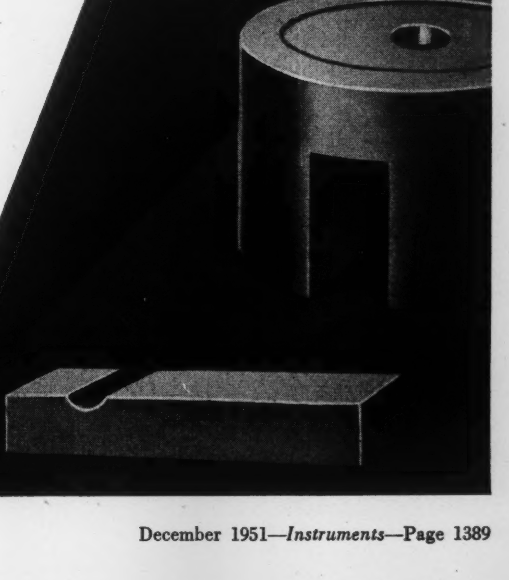
CARBOLOY

DEPARTMENT OF GENERAL ELECTRIC COMPANY

11155 E. 8 MILE STREET, DETROIT 32, MICHIGAN

FIRST IN MAN-MADE METALS FOR BETTER PRODUCTS

"Carboloy" is the trade-mark for the products of Carboloy Department of General Electric Company



PIPING COSTS

CONVENTIONAL PIPING

with

BalanSeal®

TYPE

FarriSeal

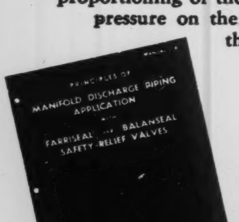
SAFETY VALVE

If your safety or relief valves discharge into a collecting header, you can effect substantial reduction in discharge piping cost by specifying BalanSeal Safety Relief Valves... economies that amount in some instances to *15 times as much as the cost of the valves themselves.*

HERE'S HOW: Because BalanSeal Safety-Relief Valves balance out the effects of discharge pressure surges, you can use much smaller discharge piping... can depend on your valves to operate at the set pressure regardless of how high the back pressure may be.

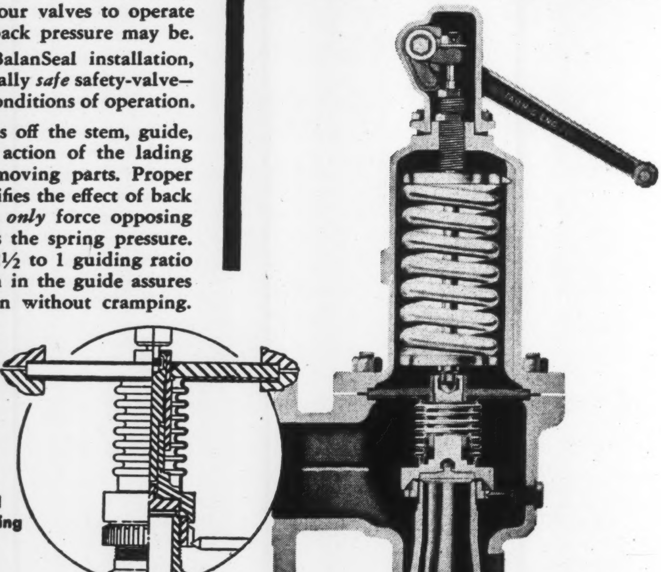
Besides this big economy feature of a BalanSeal installation, you get what you *must* expect of any really *safe* safety-valve—*positive protection* at all times and under all conditions of operation.

HERE'S WHY: The FarriSeal bellows seals off the stem, guide, and spring... protects them from corrosive action of the lading fluid... prevents freezing of the moving parts. Proper proportioning of the bellows diameter nullifies the effect of back pressure on the relieving point... the *only* force opposing the lifting of the disc is the spring pressure. Finally, the long, 2½ to 1 guiding ratio of the stem in the guide assures smooth action without cramping.


PRINCIPLES OF MANIFOLD DISCHARGE PIPING APPLICATION WITH FARRISEAL AND BALANSEAL SAFETY RELIEF VALVES

FARRIS ENGINEERING CORPORATION

You can't afford to overlook the advantages of BalanSeal—for Savings and Safety. Get your copy of MANIFOLD DISCHARGE PIPING APPLICATION—Manual 51-B—a valuable reference work on this subject.



***Patented and Patents Pending**

Farris

SAFETY and RELIEF VALVES

FARRIS ENGINEERING CORP.

Commercial Avenue Palisades Park, N. J.

1089

Now!

Transient-free test voltages down to 0.01 cps!

Versatile, general purpose generator for subsonic and audio work! Continuously variable, 0.01 to 1,000 cps, 5 bands. High stability, distortion less than 1%. Radical new circuitry offers sine, square and triangular waves.

SPECIFICATIONS

-hp- 202A Low Frequency Function Generator

FREQUENCY RANGE: 0.01 to 1,000 cps in five decade ranges.

DIAL ACCURACY: Within 2%.

FREQUENCY STABILITY: Within 1% including warm-up drift.

OUTPUT WAVEFORMS: Sinusoidal, square, and triangular.

MAXIMUM OUTPUT VOLTAGE: At least 30 volts peak-to-peak across rated load for all three waveforms.

DISTORTION: Less than 1% RMS distortion in sine wave output.

OUTPUT SYSTEM: Can be operated either balanced or single-ended. Output system is direct-coupled; dc level of output voltage remains stable over long periods of time. Adjustment available from front panel balances out of any dc.

FREQUENCY RESPONSE: Constant within 1 db.

HUM LEVEL: Less than 0.1% of maximum output.

SYNC PULSE: 5 volts peak, less than 10 μsec duration. Sync pulse occurs at crest of sine and triangular wave output.

POWER: 115-volt, 50/60 cycles, 175 watts.

DIMENSIONS: 10½" high, 19" wide, 13" deep.

PRICE: $450.00 f.o.b. Palo Alto, California. End frames, for table use, $5.00 per pair f.o.b. factory. (Specify No. 17.)

Data subject to change without notice.

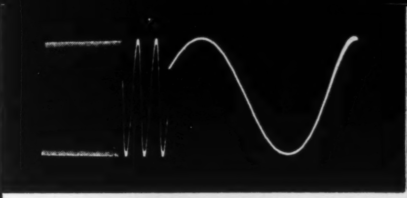


Figure 1. Oscillogram shows freedom from transients as output frequency is changed.

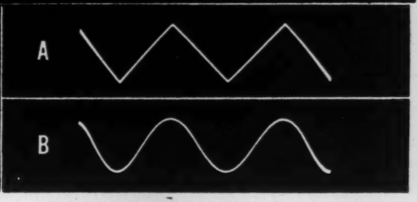


Figure 2. Oscillogram of (a) triangular wave applied to shaping circuit and (b) resulting sine wave.

–hp– 202A Low Frequency Function Generator offers you a compact, convenient and versatile source of transient-free test voltages between 1,000 and 0.01 cps. It provides virtually distortion-free signals for vibration studies, servo applications, medical and geophysical work, and other subsonic and audio problems. For such applications, the equipment generates 3 wave forms: sine, square and triangular. (Desired wave form is selected on front panel switch.) Output is 30 volts peak-to-peak for all 3 wave forms.

NEW CIRCUIT CONCEPT

–hp– 202A differs from conventional low-frequency oscillators in that the sine wave is electronically synthesized. A controlled bi-stable circuit generates a rectangular wave. This wave is passed through a special integrator providing a true triangular wave (Figure 2a). The triangular wave then enters a shaping circuit developed by *–hp–*. Here 6 duo-diodes modify or "shape" the peaks and provide a true sine wave with distortion of less than 1% (Figure 2b). This synthesizing circuit provides virtually transient-free output even when range switch is operated or frequency is rapidly varied. This circuit also maintains the amplitude constant under all conditions. It is not necessary to wait long periods for the circuit to stabilize at a new level as with conventional oscillators.

OTHER FEATURES

The output system of *–hp–* 202A is fully floating with respect to ground. May be used to supply a balanced voltage or either terminal may be grounded. It will deliver 10 v RMS to a load of 5,000 ohms or greater; internal impedance, however, is only 100 ohms. There are no coupling capacitors in the output system, and a high degree of dc balance is achieved by means of a special circuit.

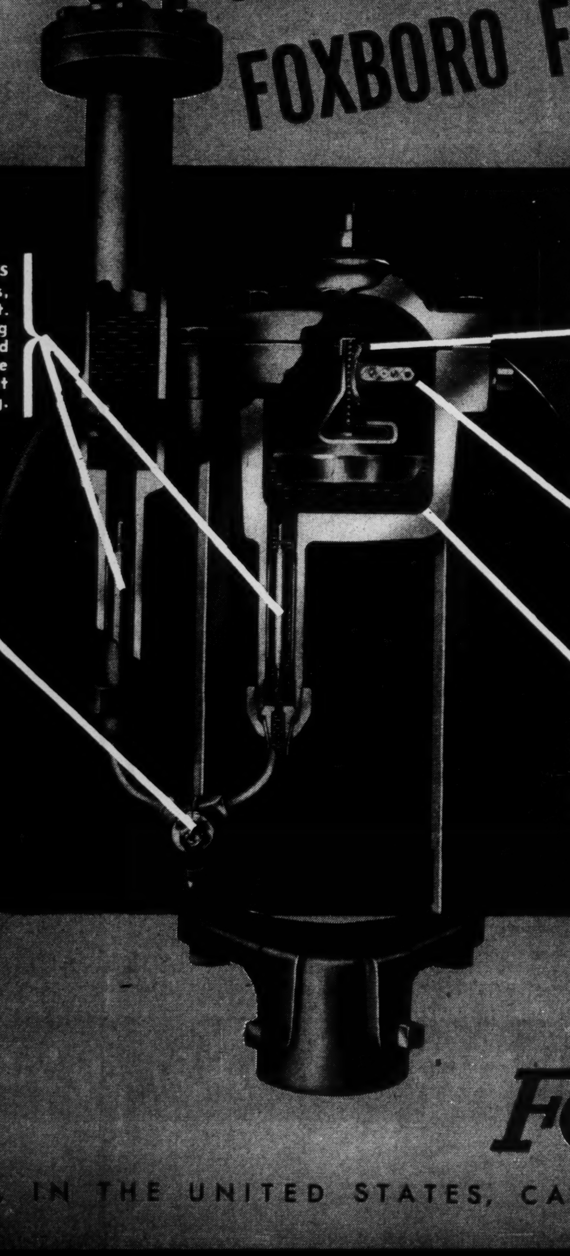
-hp- field engineers, in most major cities, have complete details. Or, write direct.

HEWLETT-PACKARD CO.
2325C Page Mill Road • Palo Alto, Calif.
Export: FRAZAR & HANSEN, LTD.
San Francisco • Los Angeles • New York

HEWLETT-PACKARD *hp* INSTRUMENTS

ANNOUNCING

New Basic Advances in the complete line of FOXBORO FLOW METERS!



NEW Check Floats with redesigned guides, ball plug and seat. Insure perfect seating every time! Submerged in mercury for complete protection against frosting and fouling.

NEW U-Bend and Damping Plug Assembly. Easy to make up tight every time because of self-aligning all-welded construction. No gasket needed. Replaceable seats. Damping plug fully adjustable under pressure. Directed drain for mercury at lowest point.

NEW Segmental Drive Assembly with stainless steel ball chain that insures free travel of float, and with positive collet-type bearing shaft clamp. Assembly also available in Type 28 Meters with complete ambient temperature compensation—an exclusive new Foxboro feature.

NEW Pressure-Seal Bearing. Revolutionary ring seal gives unequalled freedom from friction, and complete freedom from leaks, at any working pressure. Factory-lubricated—no lubricator required. Shaft and bearing both of Type 316 stainless steel.

NEW Compact Float Chamber gives greater accessibility for easier, quicker cleaning.

All parts freely interchangeable. Easy substitution of range chambers.

FOXBORO
REG. U. S. PAT. OFF.

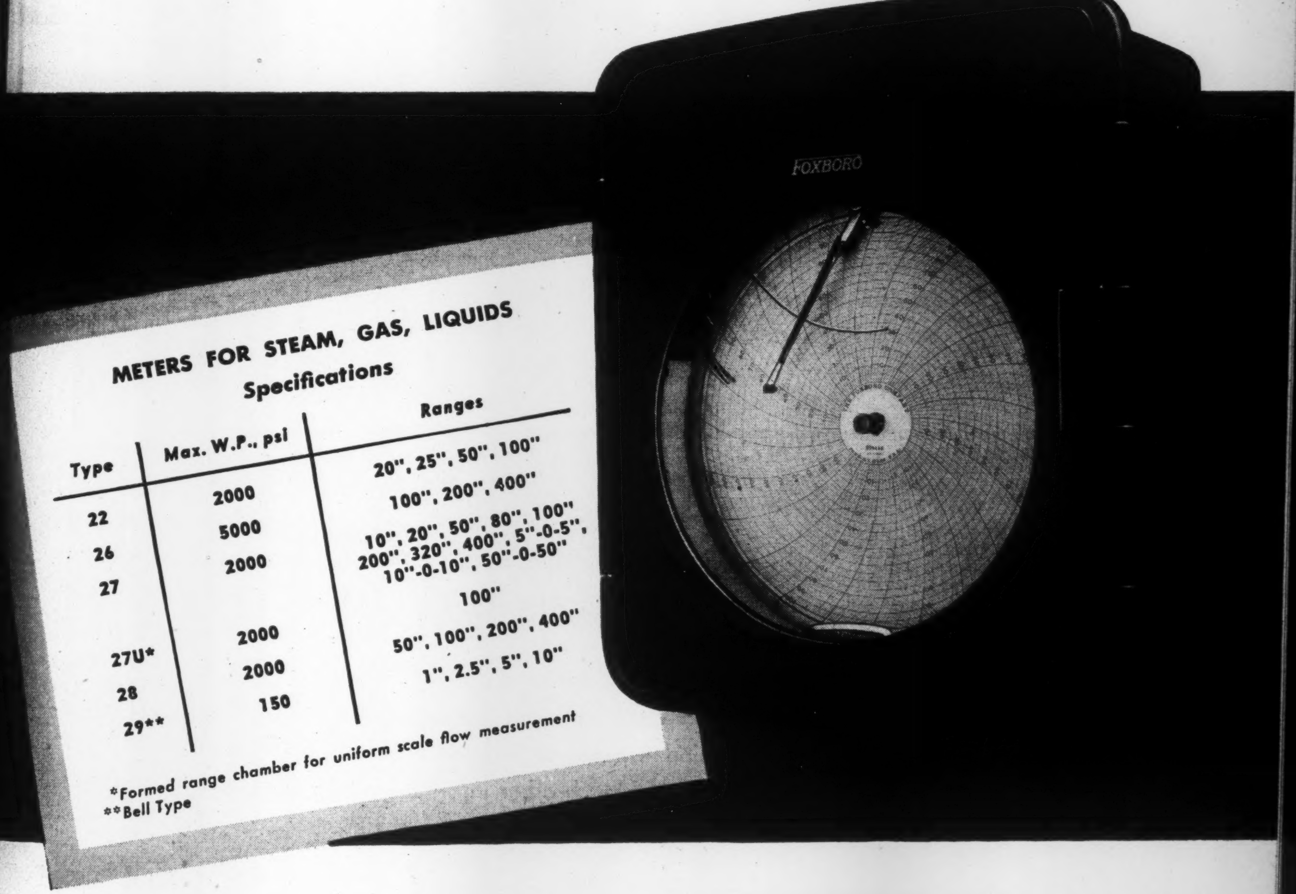
FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

Higher sustained accuracy, less maintenance than ever before!

Outstanding improvements in every basic detail of differential meter design now afford a new complete line of Foxboro Flow Meters that set an unprecedented standard of dependable accuracy.

In addition to the important features outlined on the opposite page, these new meters retain all the uniquely advantageous features of the previous Foxboro line, including large floats with long travel for added power; and floats located in high pressure chamber to minimize ambient temperature effects. The combined result is practical metering performance that's farther ahead of the field than ever before . . . in maintenance-freedom as well as sustained accuracy.

Check up on all the advantages of the new Foxboro Flow Meters. Available in round or rectangular cases . . . as indicators, recorders, controllers or transmitters . . . with or without integrators. There's a type for every metering problem. Write for New Bulletin 460. The Foxboro Company, 4612 Neponset Ave., Foxboro, Mass., U.S.A.



METERS FOR STEAM, GAS, LIQUIDS
Specifications

Type	Max. W.P., psi	Ranges
22	2000	20", 25", 50", 100"
26	5000	100", 200", 400"
27	2000	10", 20", 50", 80", 100", 200", 320", 400", 5"-0-5", 10"-0-10", 50"-0-50"
27U*	2000	100"
28	2000	50", 100", 200", 400"
29**	150	1", 2.5", 5", 10"

*Formed range chamber for uniform scale flow measurement
**Bell Type

. . First in FLOW METERS

PREDICTABLE PERFORMANCE FLOATS*

A GREAT, NEW ADVANCE IN THE SCIENCE OF "AREA" FLOW MEASUREMENT

NOW FLOWRATOR METERS CAN BE

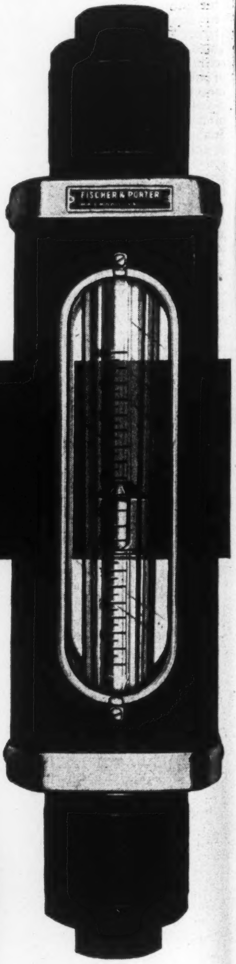
- **. . . Specified by Simple Reference to Handbook Data**
- **. . . Delivered Quickly From Stock**
- **. . . Converted Easily, by the User, From One Service to Another**

Predictable Performance flow measurement is exactly what the term indicates . . . performance under various operating conditions of temperature, gravity and viscosity that can be predetermined and accurately charted. Predictable Performance Floats in four basic shapes were developed by Fischer & Porter after five years of continuous research.

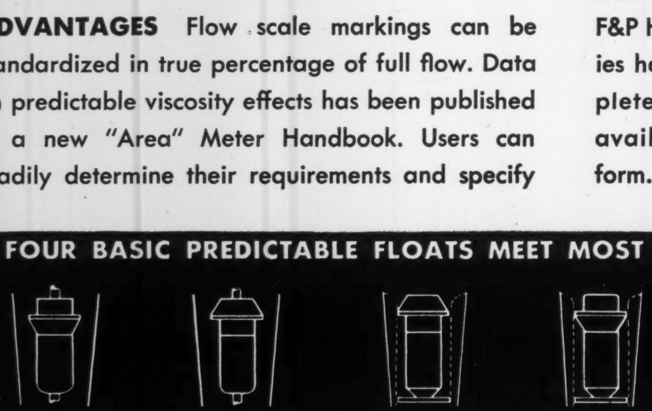
ADVANTAGES Flow scale markings can be standardized in true percentage of full flow. Data on predictable viscosity effects has been published in a new "Area" Meter Handbook. Users can readily determine their requirements and specify meters to meet them. Merely by following calibration corrections shown in Prediction Curves, any meter may be converted quickly to any service within its capacity. Meters are flexible . . . widely adaptable. Time and money are saved. Of course, all of these advantages are just as applicable to transmitting, recording and controlling instruments.

FACTOR TAGS Each meter as supplied has a factor tag applicable to the service requirement at the time of purchase. A change in service requires only a change of tag, listing new data and factor.

COMPLETE DATA AVAILABLE Thousands of hours of experimentation and research in the F&P Hydraulic Laboratories have developed complete calibration data, available in handbook form.



FOUR BASIC PREDICTABLE FLOATS MEET MOST REQUIREMENTS



* The "float" is a basic metering element and the only moving part in the FLOWRATOR variable-area flow meter.

WRITE FOR HANDBOOK The F&P Variable-Area Handbook contains a complete compilation of float lists, prediction curves, float data and selection instructions, how to use curves and change meter capacities and much other information of value to all meter users. Your copy is free for the asking.

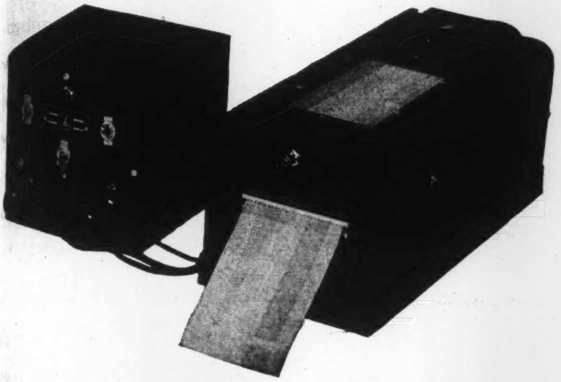
PROCESS
CONTROL
INSTRUMENTS

FLOWRATOR

FISCHER & PORTER COMPANY
HATBORO, PENNSYLVANIA, U.S.A.
SALES ENGINEERING OFFICES THROUGHOUT THE WORLD

Simplify analysis

WITH THESE *Brush* INSTRUMENTS



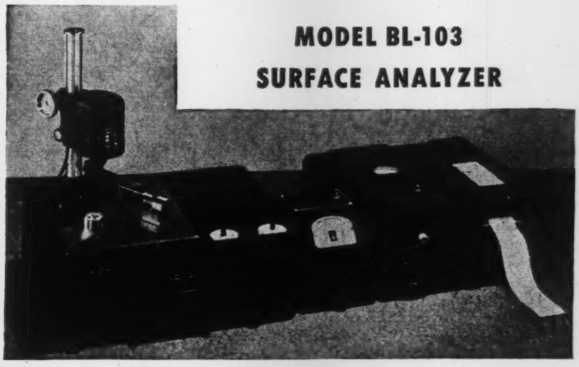
COMBINATION MAGNETIC OSCILLOGRAPH

The Model BL-221 Single Channel Magnetic Combination Oscillograph is similar to the Model BL-201 unit, except that circuit changes have been made to permit use of either a standard inking pen or an electric stylus. Magnetic penmotor Model BL-943 is used on the BL-221 Oscillograph and includes the proper connections for use of the electric stylus. A Power Supply, Model BL-944, furnishes voltage for the electric stylus operation. A switch on the front panel of the Power Supply permits the operator to increase the stylus voltage when recording high frequency phenomena. The main switch opens circuit to Power Supply to eliminate the possibility of receiving electric shock when handling stylus. Instruments are supplied with a standard pen and inkwell as well as the electric stylus. The Model BL-222 Double Channel Oscillograph (shown in illustration) is supplied on the same chassis as the BL-221.

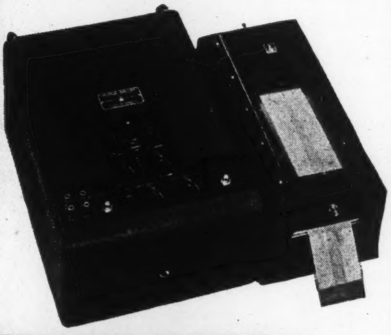
BL-932 D-C AMPLIFIER

Designed for use with the Brush Magnetic Direct Inking Oscillograph, and used to make recordings of many types of phenomena heretofore measured only with the aid of complicated intermediate equipment. Studies of such static or dynamic conditions as strains, displacements, pressures, light intensities, temperatures, d-c and a-c voltages or currents, and many others, are simplified by the use of the Brush Direct Inking Oscillograph with the BL-932 Amplifier. Voltage gain is sufficient to give one chart mm deflection per millivolt input. Novel design features reduce the effects of power line fluctuation. Zero signal drift amounts to not more than one chart mm per hour. Frequency response is essentially uniform from d-c to 100 cycles per second. The control panel at the front of the amplifier contains a factor-of-10 attenuator, gain control, calibrating meter, and controls for determining input voltages. A balancing potentiometer is provided for electrically biasing the oscillograph pen to any position on the chart.

MODEL BL-103
SURFACE ANALYZER



For exploration and instantaneous charting of surface finishes—metals, glass, plastics, paper, plated and painted surfaces from less than 1 to 5000 microinches. Complete with PA-2 Pickup Arm, Drive Head, Amplifier, Magnetic Oscillograph, Surface Plate, Carrying Cases, Glass Calibration Standard, 2 V-Blocks, 6 rolls Chart Paper, one 2 oz. bottle Red Ink, connecting cords and operating instructions. Brush RMS METER: "average reading" type calibrated in terms of the "RMS" of an equivalent sine wave. It provides a constant visual check of "RMS" surface roughness in cases where "hill and dale" chart profiles are not needed. Large illuminated dial is set at an easy reading angle. "RMS" Meter may be purchased separately or with the Surface Analyzer.

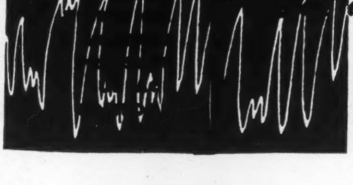


UNIVERSAL STRAIN ANALYZER

The BL-320 Universal Strain Analyzer, when used with the Brush Magnetic Direct Inking Oscillograph, provides a complete package unit for the measurement of strain or other phenomenon where a resistance sensitive pickup is employed. It can be simply operated, producing records which are immediately available and easily interpreted. This combination equipment records either static or dynamic strains up to 100 cps, and direction as well as magnitude of the measured strain can be read from the chart. Connections are brought out so that one to four active gages may be used. Provision is made for connecting an internal calibrating resistor in the bridge circuit and adjusting the overall gain.

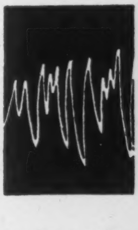
Write for complete details.

THE *Brush* DEVELOPMENT COMPANY
DEPT. A-1, 3405 PERKINS AVENUE • CLEVELAND 14, OHIO, U.S.A.
Canadian Representatives:
A. C. Wickman (Canada) Limited, P. O. Box 9, Station N, Toronto 14, Ontario

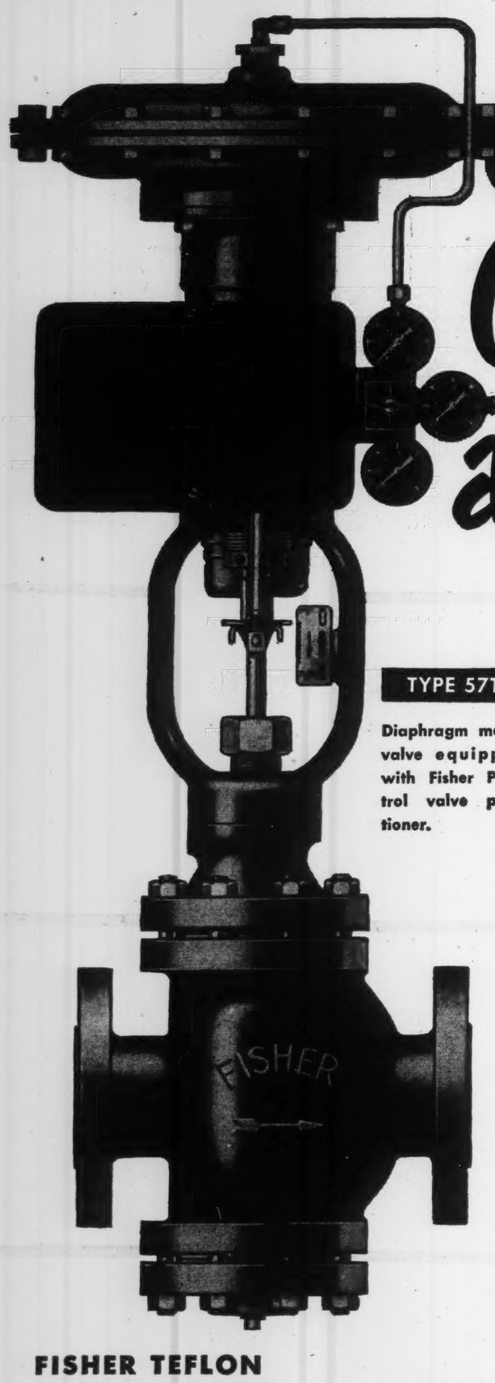


it in writing with a

BRUSH RECORDING ANALYZER



STRAIN ANALYZERS • SURFACE ANALYZERS • CONTOUR ANALYZERS • UNIVERSAL ANALYZERS • UNIFORMITY ANALYZERS



FISHER®

Offers You The and Complete Line

Features:

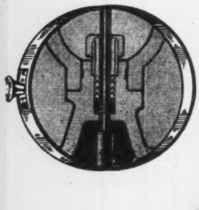
1. Large superstructure for power to overcome friction losses.
2. Fisher Teflon V-Ring Packing requires no lubrication.
3. Wall sections and boltings conform with ASA code.
4. Yoke mounting boss for valve positioner.
5. Quality controlled materials and workmanship.

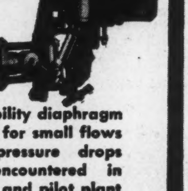
TYPE 57T

Diaphragm motor valve equipped with Fisher Positrol valve positioner.

FISHER TEFLON V-RING PACKING

- No gland leakage.
- Used on wide range of pressures without appreciable change in friction values.
- Elimination of maintenance and adjustment.
- No valve stem lubricators required.
- Chemically inert to all fluids up to 450° F.





TYPE 530

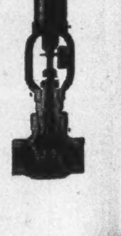
High rangeability diaphragm control valve for small flows and high pressure drops commonly encountered in experimental and pilot plant operations.

TYPE 567

Reverse action topwork, generally used with push-down-to-close valves which must be spring closed in action.

TYPE 790R

Pressure balanced diaphragm control valve — either single or double diaphragm construction — for use with remote mounted instrument or pressure loader.



TYPE 57T-D

High pressure diaphragm control valve. Available in small sizes for 3,000 lbs. and 6,000 lbs. working pressure.

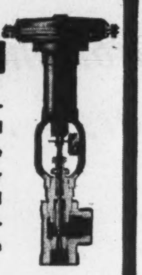
FISHER LEADS THE INDUSTRY

Industry's Most Versatile of Diaphragm Motor Valves

Illustrated here are just a few of the complete line of Fisher Governor Company diaphragm motor valves. They are manufactured to handle pressure conditions up to 10,000 pounds, for high pressure drops, for handling contaminated fluids (coke, sludge, slurry). Available in metals for highly corrosive service and alloys for high temperature work. They are built for your specific requirements with a wide choice of inner valves to provide desired flow characteristics.

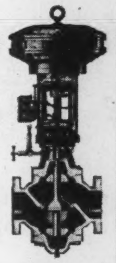
TYPE 57T-DA

High pressure diaphragm control valve. Available in small sizes for 3,000 lbs. and 6,000 lbs. working pressures with angle body.



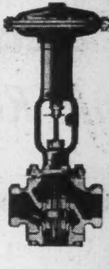
TYPE 5700

Springless type diaphragm motor valve, double diaphragm actuated. Power actuator suitable for up to 5,000 lbs. unbalanced thrust.



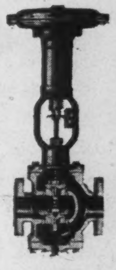
TYPE 1657S

Three-way diaphragm motor valve with single disc, double seat, commonly used on flow diversion work.



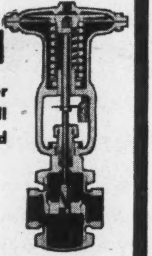
TYPE 57T-K

Diaphragm motor valve with fully balanced inner valve with soft seat for tight closure.



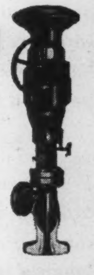
TYPE 510S

Diaphragm motor valve with small single seated bronze body.



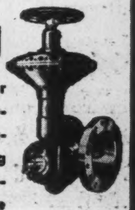
TYPE 461-462

Diaphragm motor valve with Sweep-Flo angle body and continuous connected handwheel diaphragm motor operator.



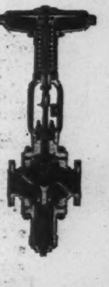
TYPE 7700

Diaphragm motor valve with butterfly valve construction for handling large volumes under low pressure drop conditions.



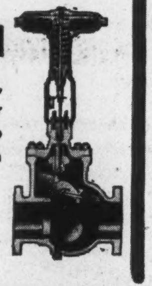
TYPE 581

Diaphragm motor valve, single seated, piston balanced with internal pilot.



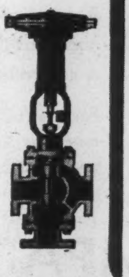
TYPE 57T-L

Single seated, flapper check for low pressure drop installations such as meter runs.



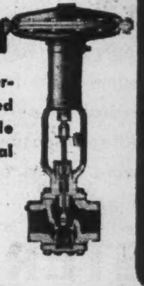
TYPE 1657T

Three-way valve, double port, double disc, full throttling.



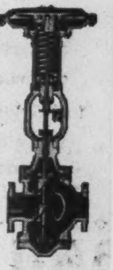
TYPE 57Q

Diaphragm operated single seated body, reversible without additional parts.



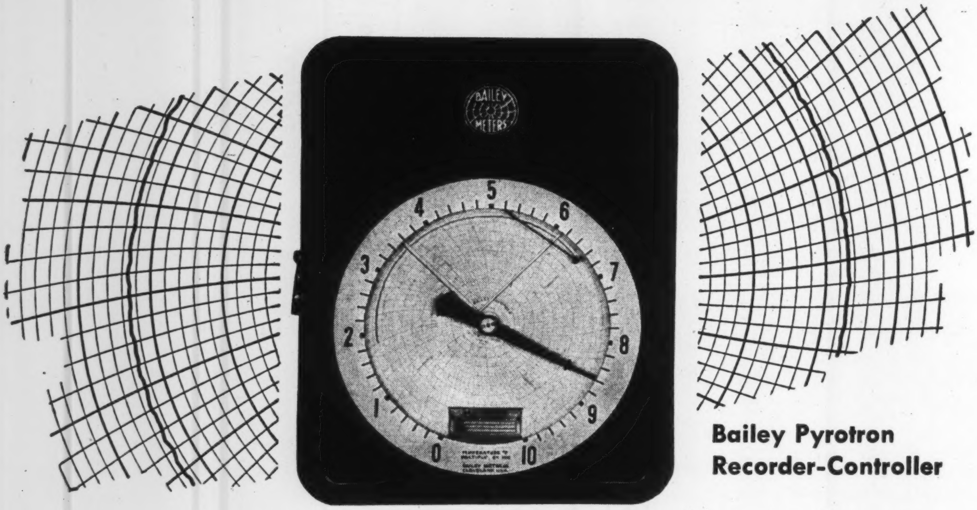
TYPE 57T

Standard diaphragm motor valve, available with variety of inner valve constructions.



FISHER GOVERNOR COMPANY, Marshalltown, Iowa

IN RESEARCH FOR BETTER PRESSURE CONTROL



Bailey Pyrotron Recorder-Controller

Looking for Better Temperature Instruments?

...Then check these features of Pyrotron Electronic Resistance Thermometers...

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between —300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

1041 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION

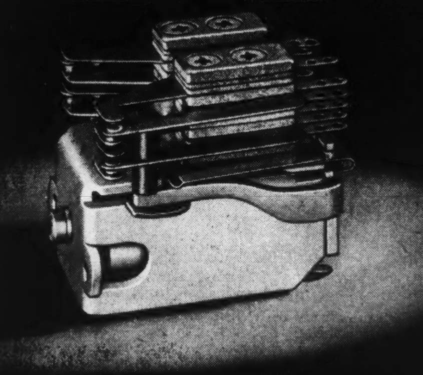
FLOW
LEVEL
DENSITY
RATIO

THE *New* CLARE TYPE "N" RELAY...

a small, highly sensitive relay

designed for efficient operation on low power*

CLARE Type "N" RELAY



SPECIFICATIONS of CLARE Type "N" RELAY

COIL

OPERATING VOLTAGE

ARMATURE

CONTACT ASSEMBLY

CONTACTS

TERMINALS

DIMENSIONS

NET WEIGHT

MOUNTING

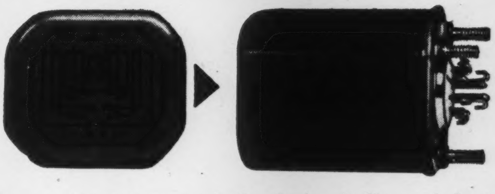
CLARE Type "N" Relays are designed for operation on extremely low power. A close-coupled magnetic circuit, generous use of magnetic iron, and unusually efficient coil design give high sensitivity while retaining high contact pressure (minimum 30 grams) and adequate contact gap (minimum 0.015").

Other important advantages include small size, light weight, and especial adaptability to hermetic sealing. Type "N" Relays having not more than 14 terminals for coil and contact springs can be hermetically sealed in enclosures of extremely small size.

For more detailed information on Clare Type "N" Relays you are invited to write for Bulletin No. 109. Clare sales engineers are located in principal cities. Call them or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

* With a 10,000-ohm coil, 1 Form C contact (spdt), and a standard adjustment, this relay will operate on less than 50 milliwatts. With a 450-ohm coil and four Form C contacts (4pdt), it will operate on 7/10 watt, even under conditions of vibration and high ambient temperature.

Clare Type "SN" Hermetically Sealed Relay

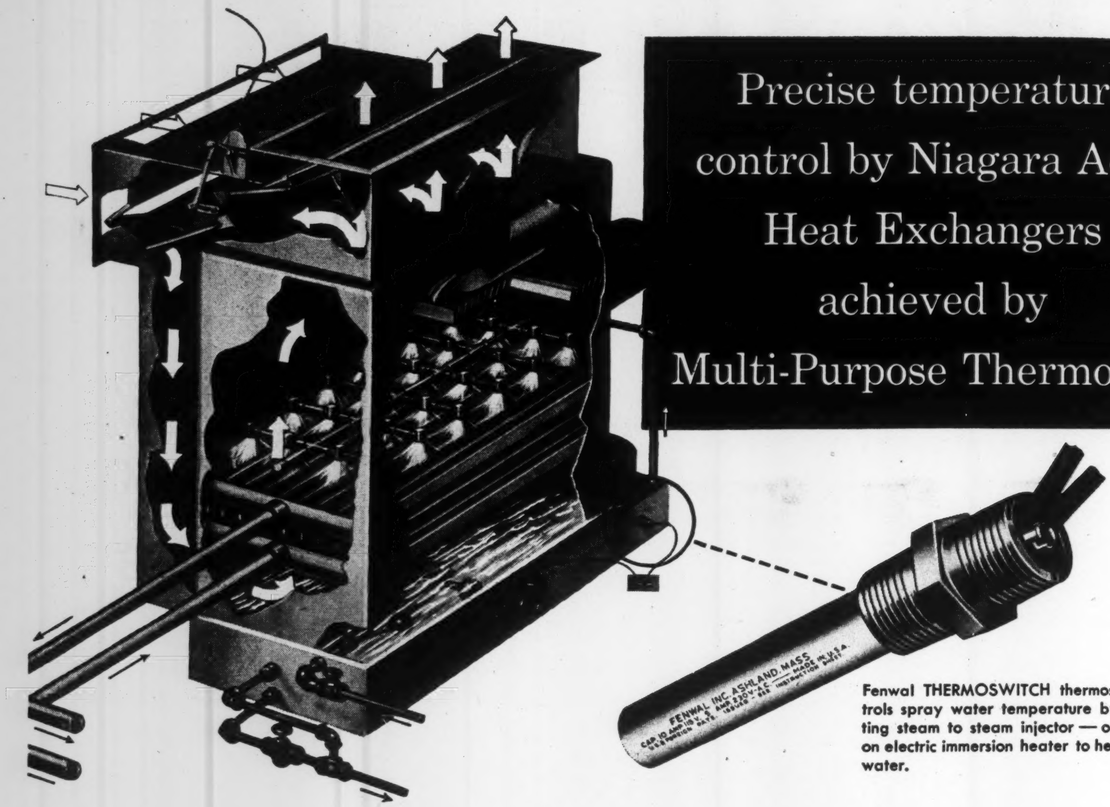


Shown above is one of the hermetically sealed steel enclosures in which the Type "N" Relay can be sealed. Dimensions are: Length: 1-7/16"; Height: 2-1/16"; Width: 1⅝". Net weight of relay having 12 contact springs, six in each pileup, is 5 oz. (approx.). Note connection diagram clearly and permanently imprinted on base of enclosure by silk screen process.

Write for CLARE Bulletin No. 109

RELAYS

Precise temperature control by Niagara Aero Heat Exchangers achieved by Multi-Purpose Thermostat


FENWAL INC. ASHLAND, MASS.
MADE IN U.S.A.
CAP. 10 AMP 115V. 5 AMP 230V.-A.C.

Fenwal THERMOSWITCH thermostat controls spray water temperature by admitting steam to steam injector — or turning on electric immersion heater to heat spray water.

These exchangers are particularly useful in chemical processes or in cooling quench baths during heat-treating of metals because their constant temperature assures uniform rate and quality in production.

One of the key points in the operation of Niagara Aero Heat Exchangers is precise temperature control of spray water.

To make sure of positive temperature control at all times, Niagara relies on a Fenwal THERMOSWITCH thermostat. This unique, low-cost unit prevents temperature of spray water from dropping below a given point by controlling steam injector or electric immersion heater which supplies additional heat. It also starts the spray pump motor.

These easy-to-install, easy-to-maintain Fenwal THERMOSWITCH thermostats are used to solve all types of control problems. Their activating control element is the single-metal shell that expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts.

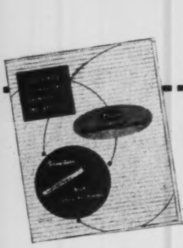
Find out now how Fenwal THERMOSWITCH units can help you. They effectively control many variables where heat is a factor. Mail coupon below for further information.

Fenwal

THERMOSWITCH®

The Precision, Multi-Purpose, Thermostat Control

SENSITIVE . . . *but only to heat*



FREE! **Get this bulletin . . . see what Fenwal THERMOSWITCH Units can do for you.** ***Just fill in coupon and mail . . . no obligation.***

FENWAL, INCORPORATED, 1712 Pleasant St., Ashland, Mass.
Los Angeles, Cal.
TEMPERATURE CONTROL ENGINEERS

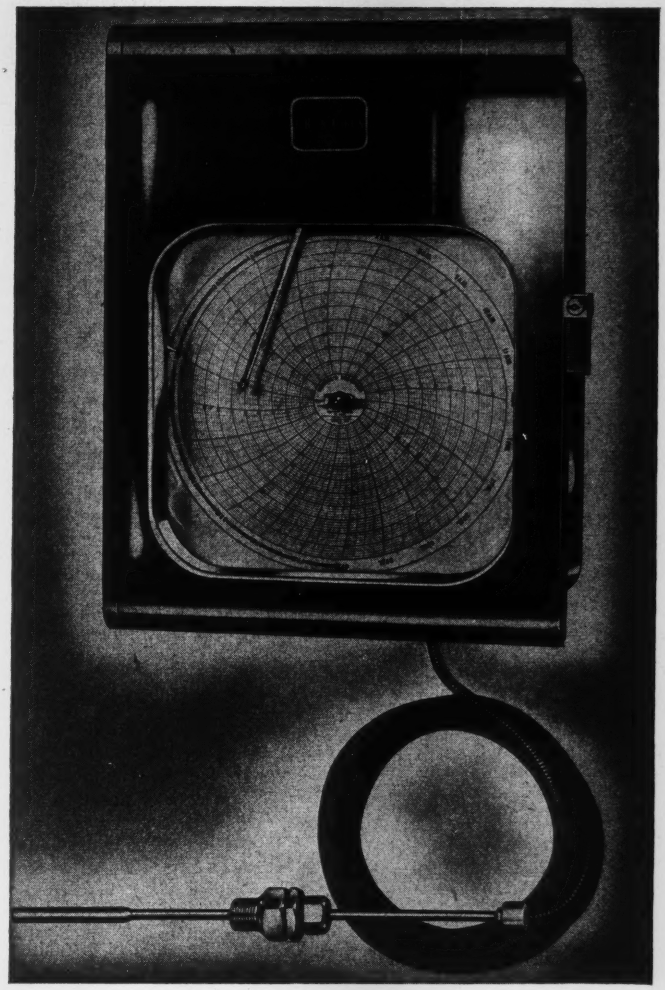
Name .... Position ....
Company ....
Street ....
City .... Zone .... State ....

I am chiefly interested in the applications checked:

☐ Heating
☐ Cooling
☐ Humidity Control or Detection
☐ Alarm (over-temperature, under-temperature)
☐ Vapor Control
☐ Timing (thermal)
☐ Radiant Heat Control
☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements) ....
....
....

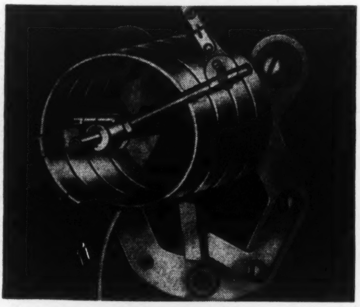
NEW SERIES 500 RECORDING THERMOMETER CARRIES ON THE BRISTOL TRADITION



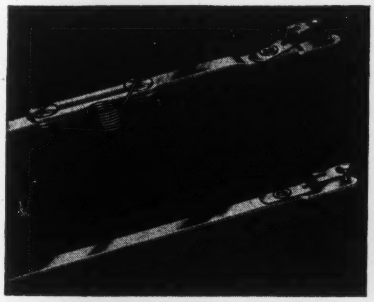
The Bristol Series 500 Recording Thermometer for temperatures between minus 125 F and 1000 F incorporates every modern improvement for dependable accuracy, ease of use and convenient servicing.

In addition, it represents all the wealth of thermometer "know-how" gained by nearly 60 years of experience in building hundreds of thousands of recording thermometers—known all over the world for their high accuracy and dependability.

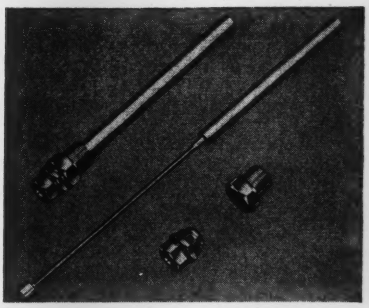
Send for the new Thermometer Catalog T840. Address THE BRISTOL COMPANY, 113 Bristol Road, Waterbury 20, Conn.



MORE SECURELY SEALED—TROUBLE-FREE —The measuring system is securely sealed against leakage. Parts are joined with silver solder by induction heating.



STURDY, FRICTION-FREE CONNECTION between measuring element and pen arm mechanism is provided by strong, adjustable links with polished stainless steel pins.

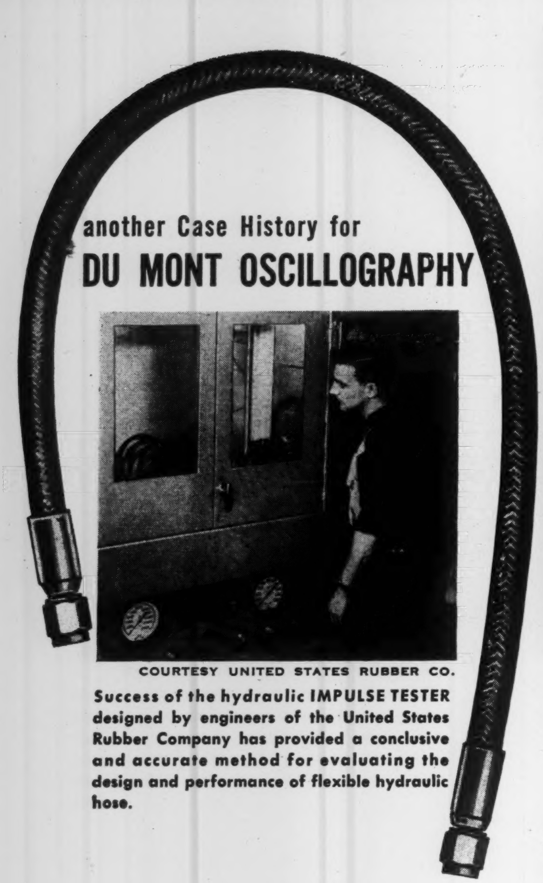


FLEXIBLE ARMOR is interlock-type, withstands heaviest abuse. *Bulbs*—plain, union or socket type—easily converted.

THE DEPENDABLE GUIDEPOST OF INDUSTRY

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



another Case History for

DU MONT OSCILLOGRAPHY

COURTESY UNITED STATES RUBBER CO.

Success of the hydraulic IMPULSE TESTER designed by engineers of the United States Rubber Company has provided a conclusive and accurate method for evaluating the design and performance of flexible hydraulic hose.

COURTESY UNITED STATES RUBBER CO.

With its slow, driven sweeps, and d-c amplification, the Du Mont Type 250-AH CATHODE-RAY OSCILLOGRAPH is an important key to the accuracy of this "fatigue test," and to the proper operation of the impulse-test equipment.

an approved hydraulic impulse test

● Engineers of the United States Rubber Company have designed and built a prime mover whose pressure output can be tailored to conform with strict impulse-test specifications – particularly those for hydraulic hose MIL-H5511 and MIL-H5512. Through their development, it is now possible to produce *test-proved* hose for the hydraulic systems operating landing gears and control surfaces in government aircraft. And their understanding of the inherent capabilities of the cathode-ray oscillograph and its application has contributed to the completeness and accuracy of this impulse-test technique.

Thirty five times a minute, for fifty continuous hours, test lengths of the hydraulic hose are subjected to controlled dynamic pressure pulses which rise to 150% of rated pressure. Air-aged, oil-aged, and unaged hose is impulse-tested under conditions of excessive tension and unusual compression and must withstand the stresses applied under these hydraulic shocks without exhibiting fatigue.

Simultaneously, each control-impulse cycle is applied to the cathode-ray oscillograph, where both static and dynamic levels of the pressure pulse are recorded. And, because the pressure pattern can be observed in complete detail on the cathode-ray oscillograph, slightest deformation of the hose is detected as a deviation from the specified pressure-pulse pattern.

Also, faulty operation of the Impulse Tester can be detected on the cathode-ray oscillograph. And by proper interpretation of this pattern, troubles can be localized and corrected quickly.

The functions of the cathode-ray oscillograph in this hydraulic application are but typical of the diversity of fields in which it is finding more and more important uses.

DUMONT *for Oscillography*

Allen B. Du Mont Laboratories, Inc., Instrument Division, 1000 Main Ave., Clifton, N.J.

Photo—Fairchild Aerial Survey, Inc.

the wheelco capacilog recorder

Baltimore industry, like industry throughout the Eastern Seaboard, has need for a low cost, highly accurate instrument for the rapid measurement, indication, control and recording of electrically measurable variables in the production processes. That's why Baltimore production men, like progressive plant men throughout the nation, specify the Wheelco Capacilog, deflection type, strip chart recorder. They demand the most efficient, versatile and accurate recorder in the most reasonable price range.

Yes, for accuracy to ¼ of 1% of total scale, they specify the Wheelco Capacilog. Capacilogs are built for use with thermocouples and resistance thermometer measuring elements; as single or multipoint recorders; and with six different control combinations including pneumatic and proportioning types. Remember, in Baltimore and throughout the nation, wherever production demands accuracy, Wheelco Capacilog Recorders are specified.

Assembly line production and simplicity of construction make it possible to deliver most models within 20 days.

Wheelco Instruments Company, 833 W. Harrison Street, Chicago 7, Illinois

wheelco *electronic controls*

FORCE MEASUREMENT problems?

The HAGAN THRUSTORQ will help solve them.

The air-operated Hagan THRUSTORQ, which converts a force or a weight into an air pressure, can be applied to problems involving force measurement.

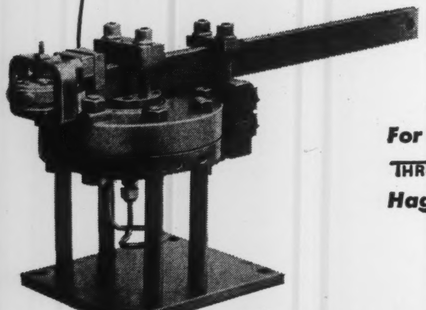
The list below will give you an idea of some successful applications of Hagan THRUSTORQ.

★ **testing piston rings**
★ **spring testing machines**
★ **jet engine thrust measurement**
★ **automatic batch weighing**
★ **rocket thrust measurement**
★ **cradle dynamometer measurement of airplane and automobile engines.**

For information about the application of Hagan THRUSTORQ to your particular problems write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN THRUSTORQ
measuring thrust and torque *with air!*

HAGAN
HALL
BUROMIN
CALGON



New Resistance Thermometers Accurately Indicate and Control Low Temperatures

TEMPERATURES FROM — 100F to +300 F can now be accurately indicated and controlled with General Electric's new line of resistance thermometers. They indicate accurately within ¾ of 1 per cent full scale. Any change in temperature equivalent to 1/10 of 1 per cent full scale starts immediate control action.

Normal changes in humidity or room temperature do not affect the exactness of control. Neither does a change in control voltage. Sturdy, simple construction assures reliable operation under severe operating conditions.

NARROW TEMPERATURE SPANS, as small as 90 degrees, are available anywhere in the —100 F to +300 F range. You can buy four types of resistance thermometers—indicators, protectors, and two- or three-position controllers—for either flush or surface mounting.

For complete information, mail the coupon below.

G-E Pyrometer Equipment Quick and Easy to Inspect, Maintain

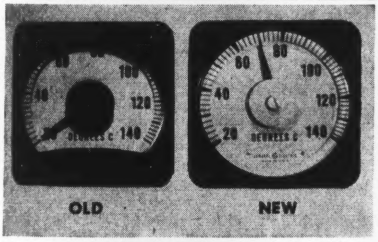
Routine inspections of new General Electric Type HP pyrometers can quickly be made. Besides making preventative maintenance easy, this equipment has many other features to provide accurate indication and temperature control of furnaces, ovens kilns, and other industrial heating equipment.

ACCURATE WITHIN ¾ OF 1% full scale, HP-3 pyrometers have automatic cold-junction compensation that adjusts for changes in ambient temperature.

Any change in temperature, even as small as 0.1% full scale, starts immediate control action. Normal changes in humidity, ambient, and voltage have little or no effect on the exactness of control action.

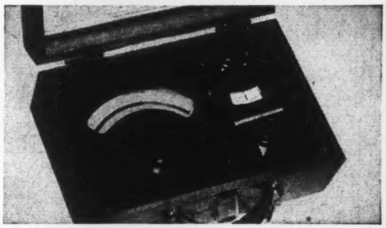
FOUR TYPES AVAILABLE—indicating, protecting, two- and three-position control forms; also both flush and surface mountings. All available in a variety of temperature ranges in the 0-3000 F span.

Mail the coupon for complete information about Type HP pyrometers.



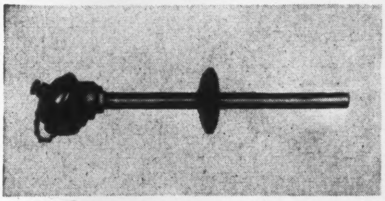
New Shadow-proof Temperature Indicators Are Easier to Read

Temperatures from —100 F to +300 F can now be accurately indicated and controlled with General Electric's new line of temperature indicators. These instruments can be read from almost any angle. The dial is set forward, flush with the front of the case. A protruding convex-type glass front provides clear illumination. No more cover overhang; no more shadows caused by overhead lighting. Two sizes available—4¼- and 8¾-inches. Check coupon.



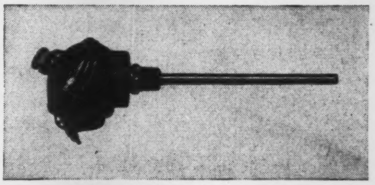
THERMOCOUPLE POTENTIOMETER measures temperature in locations inaccessible to glass-stem thermometers. Any number of different readings can be taken in rapid succession and accurate within ±0.2% of full scale.

Typical applications include refrigerator-development work, oil-burner and air-conditioning tests, steam temperature measurements, and heat-run tests on electric equipment. For complete information, mail the coupon below.



THERMOCOUPLES, COMPONENTS, AND ACCESSORIES for your pyrometer installations include protecting tubes and wells, thermocouple wire, ceramic insulators, extension wire, connectors, heads, selector switches. Send coupon today for catalog to help you obtain proper thermocouple assemblies.

Resistance Bulbs Accurate Within ±1 F between —100 F and +300 F



FOR ANY RESISTANCE THERMOMETER INSTALLATION, new G-E resistance bulbs offer a high degree of accuracy and reliability. They're available either with completely enclosed terminal head or without terminal head and with four feet of flexible cable. Units will retain calibration within 0.1 F. For complete information, mail the coupon below.

SECTION F 602-227, GENERAL ELECTRIC
SCHENECTADY 5, N. Y.

Please send me the following bulletins: Indicate:

- √ for reference only
- x for planning an immediate project
- ☐ Resistance Thermometer (GEC-835)
- ☐ Resistance Bulb (GEC-835)
- ☐ Type HP-3 Pyrometer (GEC-713)
- ☐ Temperature Indicators (GEC-218B)
- ☐ Thermocouples, Accessories (GEC-714)
- ☐ Thermocouple Potentiometer (GEC-245)

NAME ....

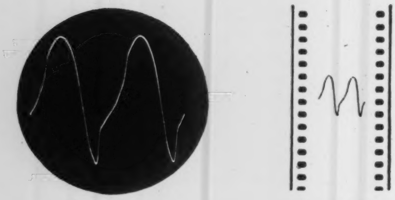
COMPANY ....

STREET ....

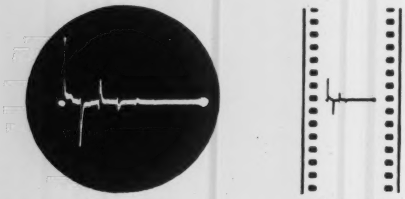
CITY .... ZONE ...... STATE ....

GENERAL ELECTRIC

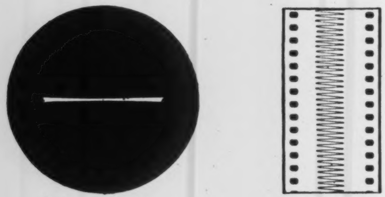
How much can you expect an oscilloscope camera to do?



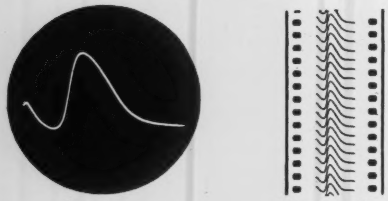
1. Single-frame photography of stationary patterns using a continuously running sweep.



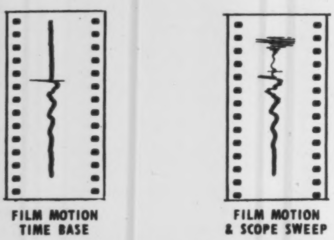
2. Single-frame photography of single transients using a single sweep.



3. Continuous-motion photography employing film motion as a time base.



4. Continuous-motion photography employing oscilloscope sweep as a time base.



5. Continuous-motion photography employing combination of film motion and oscilloscope sweep as a time base.

It's only reasonable that you should expect the oscilloscope camera you buy to record what you see on an oscilloscope screen during any period. But can it be expected to do any more? We think so.

For example, did you know that the *Fairchild Oscillo-Record Camera*—our idea of the most versatile 35-millimeter oscilloscope camera now available—can GREATLY EXTEND THE USEFULNESS OF YOUR OSCILLOSCOPE?

As you know, many non-recurring phenomena occur too rapidly to permit adequate visual study. Others occur so slowly that continuity is lost. Sometimes you have combinations of very slow-speed phenomena and occasional high-speed transients. In any one of these cases, the Fairchild Oscillo-Record Camera will take over where your eye and the oscilloscope leave off.

This extremely versatile instrument is now being used daily by many hundreds of engineers in widely divergent fields. For an idea of what it can do for you, study the five scope images and recordings illustrated at left. Each solves a particular problem.

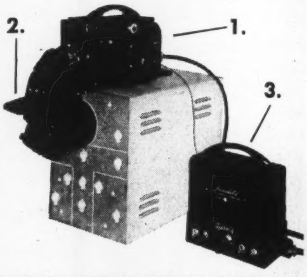
Oscillo-Record users especially like its:

CONTINUOUSLY VARIABLE SPEED CONTROL—1 in./min. to 3600 in./min.

TOP OF SCOPE MOUNTING that leaves controls easily accessible.

PROVISION FOR 3 LENGTHS OF FILM—100, 400, or 1000 feet.

For more data write *Fairchild Camera Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. Dept. 120-16F1.*

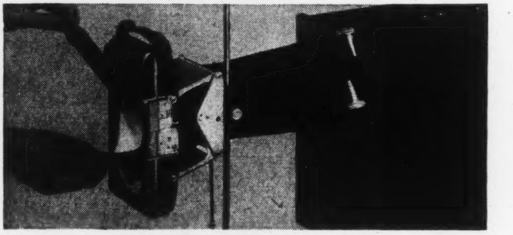


FAIRCHILD OSCILLO-RECORD CAMERA—1. camera, 2. periscope, 3. electronic control unit. *Available accessories include external 400 and 1000 foot magazines, magazine adaptor and motor, universal mount for camera and periscope, binocular split-beam viewer.*

VALUABLE RECORDS FOR IMMEDIATE EVALUATION

The Fairchild-Polaroid® Oscilloscope Camera produces a photographic print in a minute

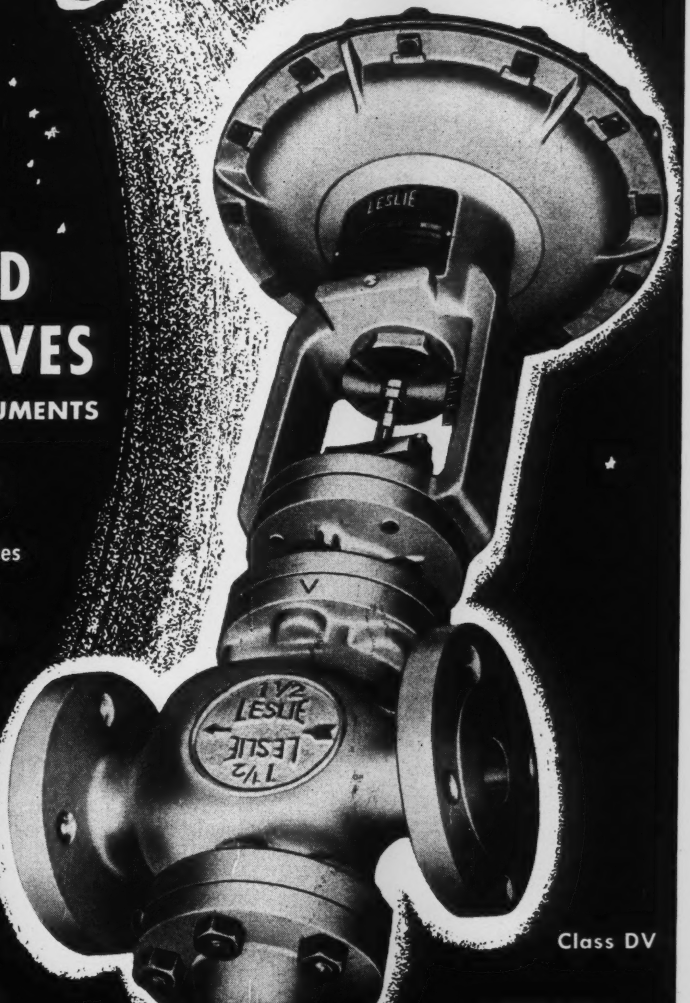
Valuable but inexpensive oscillograms for immediate evaluation; automatic one-minute processing without a darkroom; a set up time of two minutes or less—they're just three of the many advantages that are yours when you use the Fairchild-Polaroid Oscilloscope Camera. Wherever individual exposures meet your recording requirements—where you'd like to have permanent records of the traces you're now sketching or carrying in your memory, this is the camera that can bring new speed, ease and economy to your job. Prints are 3¼x4¼ and each records two traces exactly one-half life size. Write today for details.



A minute after you've pulled the tab a finished print is ready for evaluation

FAIRCHILD

OSCILLOSCOPE RECORDING CAMERAS



Class DV

Announcing the New

TRADE
LESLIE
MARK

DOUBLE SEATED DIAPHRAGM VALVES

— for use with CONTROL INSTRUMENTS

Offering these Important Features:

★ "FLOW-LINE" CONTOURED BODY—provides high capacity at low pressure drop.

★ STANDARD ISA FACE-TO-FACE DIMENSIONS

★ STELLITED SEATING SURFACES

★ RENEWABLE SELF-ALIGNING GUIDES

★ POWERFUL, COMPACT FRICTION-FREE DIAPHRAGM SUPERSTRUCTURE

★ THROUGH-BOLT CONSTRUCTION ON STEEL VALVES

★ WIDE RANGEABILITY

★ SEAT RINGS EASILY REPLACED WITH VALVE IN PIPELINE—not necessary to set up in a lathe or grind in at high temperature.

WRITE FOR
Bulletin 513

Available with various size superstructures. Sizes 1½" to 10" in Cast Steel and Cast Iron.

Look for LESLIE REGULATORS under "Valves" or "Regulators" in your classified telephone directory in the following cities where LESLIE factory trained engineers are located:

Albany, N. Y.
Albuquerque, N. M.
Atlanta, Ga.
Baltimore, Md.
Beaumont, Texas
Birmingham, Ala.
Boston, Mass.
Bridgeport, Conn.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Dallas, Texas
Denver, Colo.
Des Moines, Ia.
Detroit, Mich.
Duluth, Minn.
Greensboro, N. C.
Greenville, S. C.
Houston, Texas
Kansas City, Mo.
Kingsport, Tenn.
Los Angeles, Cal.
Louisville, Ky.
Memphis, Tenn.
Miami Springs, Fla.
Milwaukee, Wis.
Minneapolis, Minn.
Mobile, Ala.
New Orleans, La.
New York, N. Y.
Orlando, Fla.
Philadelphia, Pa.
Pittsburgh, Pa.
Ponca City, Okla.
Portland, Ore.
Providence, R. I.
Richmond, Va.
Rochester, N. Y.
Rutherford, N. J.
Salt Lake City, Utah
San Francisco, Cal.
Seattle, Wash.
St. Louis, Mo.
Syracuse, N. Y.
Tarrytown, N. Y.
Tucson, Ariz.
Wilmington, Calif.
Youngstown, Ohio
Montreal, Que., Can.
Toronto, Ont., Can.
Vancouver, B.C., Can.
Bruxelles Forest, Belgium

ESTABLISHED 1900
LESLIE CO.

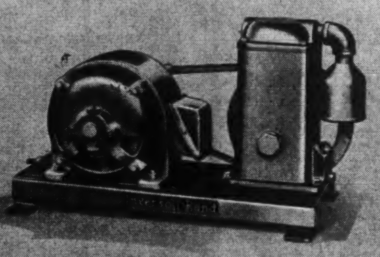
1503

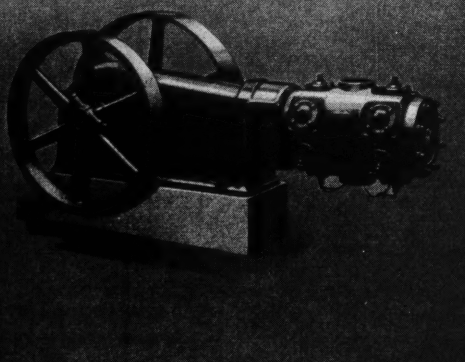
299 Grant Avenue, Lyndhurst, New Jersey

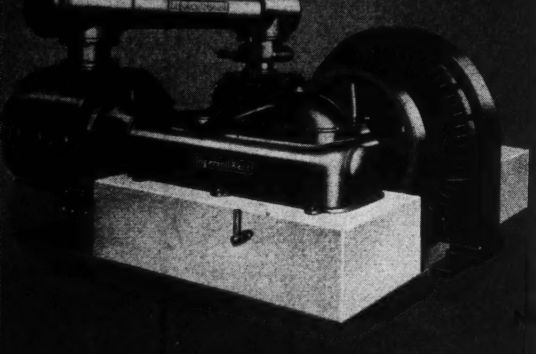
PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS
FLOATLESS LEVEL CONTROLS • PUMP GOVERNORS • TEMPERATURE REGULATORS
SELF CLEANING STRAINERS • AIR HORNS • STEAM WHISTLES

Oil Free Air for your Instruments

INGERSOLL-RAND HAS NL COMPRESSORS FROM THE SMALLEST TO THE LARGEST







Air-operated instruments, like production tools, are vitally important. That's why so many plants are using Ingersoll-Rand NL air compressors, that *don't pump oil.* This guards against instrument failures caused by oil-laden air.

Non-lubricated compressors, pioneered by I-R, feature pistons fitted with graphitic-carbon rings that prevent metallic contact of the piston with the cylinder bore. These carbon rings are segmental with metallic inner expanding rings, to give the proper wall pressure. Because metallic contact is eliminated, and the rings are self-lubricating, the Ingersoll-Rand NL Compressor cylinders require no lubricant.

To really put an end to production delays and excessive maintenance costs caused by oil-clogged instruments, get all the engineering facts and figures I-R makes available. Simply contact your nearest I-R representative, or write direct to Ingersoll-Rand, 11 Broadway, New York 4, New York.

Model N machines available through 1 hp.
Model 235 HNL machines available through 3 hp—other models through 250 hp.

Ingersoll-Rand

717-3

N Compressors . . . 70 years of compressor "know-how" packed into these new compressors for air operated instruments!

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

*

COMPARE

THIS FEATURE

OF THE HONEYWELL

SERIES "700"

VALVE

* Compare the Upper Stem Guide of this valve with that of any other wide band proportional type. Look at it closely . . . study it feature by feature.

Then check the other features of the valve . . . the Specially Designed Diaphragm, the One-Piece Bonnet, the Packless Bellows Seal, the Safety Stem Lubricator, the wide variety of discs, the easy reversibility in the field.

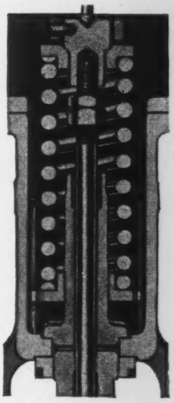
Your comparison will prove that the Honeywell Series 700 has *all* of the features you look for in a fine valve.

It's available in a wide range of styles and sizes. For detailed information, write for a copy of Bulletin 700-3 or call in your local Honeywell engineer . . . he is as near as your phone.

Minneapolis-Honeywell Regulator Co., *Industrial Division*, 1908 Windrim Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

New Bulletin 750, "Control Valve Sizing Data," is now available

DUPLEX UPPER STEM GUIDE



Two bearings guide stainless steel upper valve stem. Top bearing is self-oiling; lower bearing is lubricated by an easily accessible grease cup. Continuous lubrication assures almost frictionless super structure responsive to slightest change in signal air pressure.

687
700
4477-1
HONEYWELL

Specially Designed Neoprene Diaphragm

One-Piece Bonnet

Packless Bellows Seal

Safety Stem Lubricator

Wide Variety of Discs

Reversibility in the Field

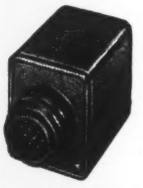
MINNEAPOLIS
Honeywell
Valve Products

ONE OF
GUARDIAN

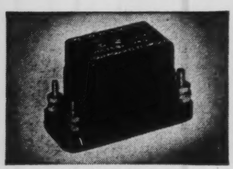
FOR GIFTS OF PEACE OR TOO OF DEFENSE

Relays BY GUARDIAN SERVE ALL FRONTS!

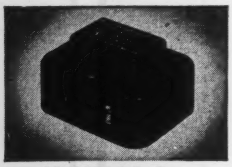
WHETHER FOR PEACE OR DEFENSE a great responsibility is vested in electrical control. In this era of defense there is an urgent demand for electrical controls in *quantity* with the highest degree of *quality* at economical cost. How efficiently Guardian Electric has moved to meet these requirements is convincingly told by the millions of Government Approved Controls by Guardian now being used in planes . . . in tanks . . . in communications . . . in bomb releases . . . in radar . . . in guided missiles . . . in gun controls. The same excellent controls that helped to insure Victory in World War II! If yours is a problem of electrical control requiring relays, steppers, contactors, control assemblies, or the familiar "Guard-A-Seal" *hermetically sealed* relays, consult Guardian. Write.



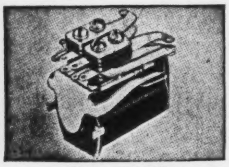
A.N. CONNECTOR PLUG
HERMETIC SEALED
CONTAINER



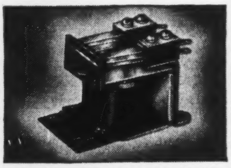
AN-3320-1 D.C.



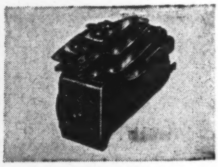
AN-3324-1 D.C.



Series 595 D.C.



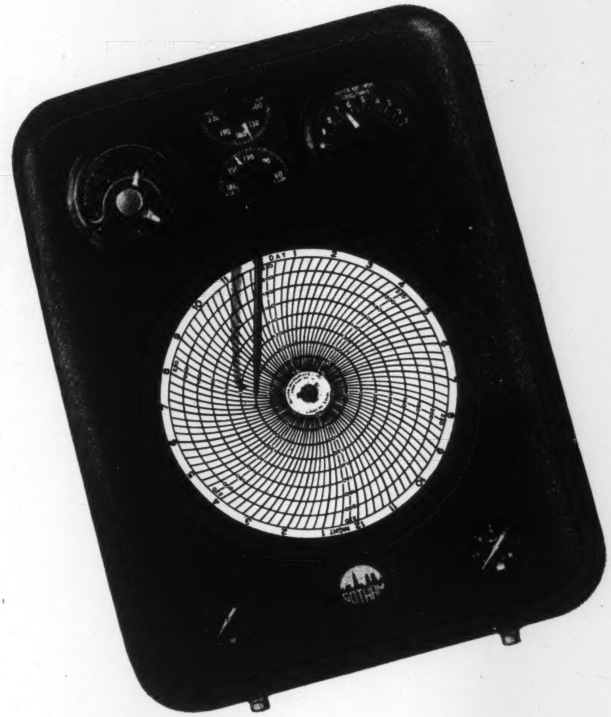
Series 610 A.C.—615 D.C.



Series 695 D.C.

GUARDIAN G ELECTRIC
1628-P W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

NEW PROGRAM CONTROLLER AS EASY TO ADJUST AS YOUR RADIO



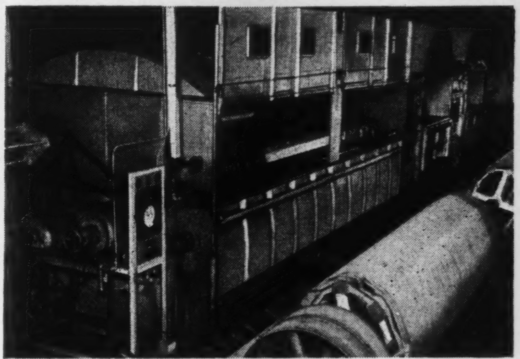
Gotham, first to bring you a completely enclosed Program Controller, was also first to conceive of all adjustments from the outside of the case. With the new Gotham Program Controller, incorporating the new outside adjustment principle, you can set the time, rate of rise, hold, and rate of cooling as easily as you tune your radio. You can control either temperature or pressure vs. time. Write for Catalog No. 500 describing in full the construction, operation, and application of the new Gotham Program Controller.

GOTHAM INSTRUMENTS

Keep Everything Under Control With Gotham

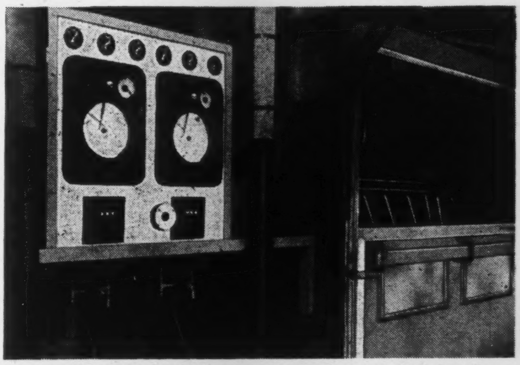
60 Gotham PC's at Botany

Over 60 Gotham Program Controllers are in use by famous Botany Mills, Inc., Passaic, N. J.



ONE OF WORLD'S LARGEST DYE KETTLES is at Botany and its dyeing cycle is supervised by Gotham Program Controller. Program control helps to maintain uniformity of the color.

12 TOP DYE KETTLE program controller units by Gotham are installed at Botany. Program control enables Botany to adjust quickly the variable time cycles required to get level dyeing.



EACH OF 48 DYE KETTLES like this at Botany, used for piece goods, is individually handled by its own Gotham Program Controller.

Photos: courtesy of Botany Mills, Inc.

GOTHAM INSTRUMENTS
Division of American Machine and Metals, Inc.
Dept. 2, 233 Broadway, New York 12, N. Y

Please send me a copy of your latest catalog and more information about Gotham ☐ Program Controllers ☐ Timers ☐ Recorders ☐ Have your man call. No obligation, of course.

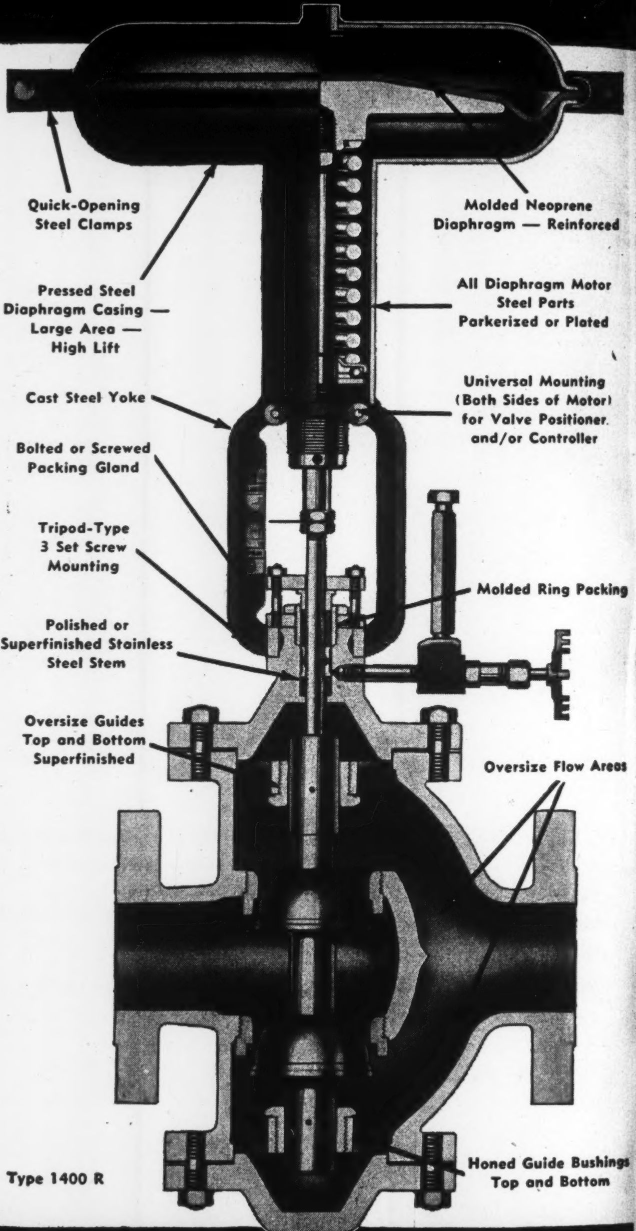
Name ________________ Title ________________
Company ________________
Address ________________
City ________________ Zone ______ State ________________

Why Most Leading Companies Are Using K & M Control Valves

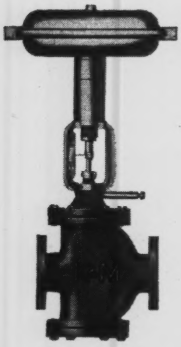
It is logical that leading companies should handle the important subject of control valves as they do other matters: They make use of the best available skills and thinking. More and more, they utilize the equipment, knowledge and facilities of the K & M engineering and service team.

Five years ago, K & M Advanced-Type Control Valves were new to industry. Today, with outstanding performance records behind them, K & M valves have become first in the regard of many instrument engineers. Increasingly, K & M representatives are called upon to give counsel and assistance in the planning of new control installations and the improvement of old ones. During the past year K & M men have been consulted on most of the projects in which control valves have been a major consideration.

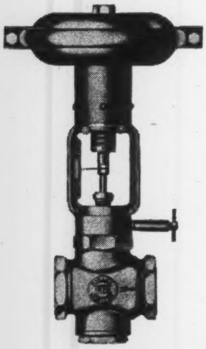
There is a qualified K & M representative near you, eager to discuss your problems and able to help you with them.


Quick-Opening Steel Clamps
Molded Neoprene Diaphragm — Reinforced
Pressed Steel Diaphragm Casing — Large Area — High Lift
All Diaphragm Motor Steel Parts Parkerized or Plated
Cast Steel Yoke
Universal Mounting (Both Sides of Motor) for Valve Positioner and/or Controller
Bolted or Screwed Packing Gland
Tripod-Type 3 Set Screw Mounting
Molded Ring Packing
Polished or Superfinished Stainless Steel Stem
Oversize Guides Top and Bottom Superfinished
Oversize Flow Areas
Honed Guide Bushings Top and Bottom

Type 1400 R



Type 1200



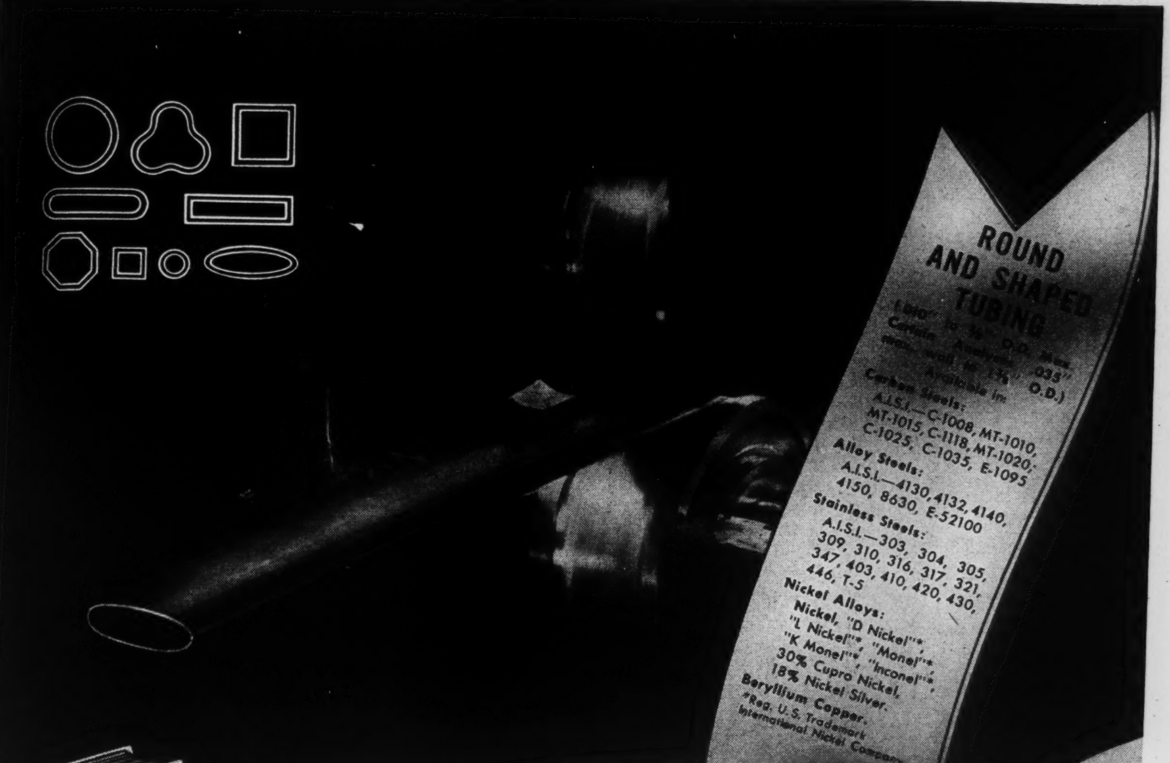
Type 1000

K&M

KIELEY & MUELLER, INC.

Valve Makers Since 1879

2017—43rd STREET
NORTH BERGEN, N. J.


ROUND AND SHAPED TUBING
(.010" to ⅝" O.D. Max. Certain Analyses .035" max. wall to 1⅜" O.D.)
Available in:
Carbon Steels:
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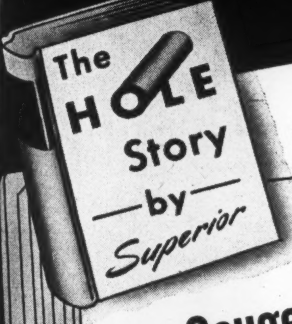

The HOLE Story
—by—
Superior

Chapter 1

Shaping a Heart for a Pressure Gauge Requires "Technology in Tubing"

Soon after the tube pictured above comes off the shaping roll, it will be processed into a Bourdon tube, the heart of a pressure gauge, by one of our customers.

The design of a gauge movement and the skill of the gauge builder have a bearing on its accuracy. But nothing can compensate for an irregularly responding Bourdon tube.

That's where Superior comes in. The metallurgy of the tube, its dimensional precision and physical characteristics are all critical . . . and all are rigidly controlled at Superior.

This rigid control is applied to all tubing produced by Superior.

For example, in the production of seamless steel tubing for hydraulic applications, industry standards permit a carbon range of .08 to .18%. This range is not good enough for Superior. Aiming for a carbon content of .12%; Superior Hydraulic Quality tubing is always held to .15% maximum. This insistence on adherence to strict standards applies equally to dimensional tolerances.

Superior produces tubing to rigid specifications year in and year out. We have the engineers, metallurgists, research, production and test facilities that it takes to draw the highest quality small tubing in the widest variety of analyses.

You can call this combination of facilities, men, methods and machines "know-how" . . . or you can call it experience. But whatever you call it the result is always fine small tubing to do a better job for you. SUPERIOR TUBE COMPANY, 1968 Germantown Avenue, Norristown, Pa.

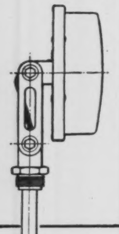
West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331.

Superior
THE BIG NAME IN SMALL TUBING
All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall)
Up to 1⅜" O.D.

PALMER

mercury actuated Dial Thermometers

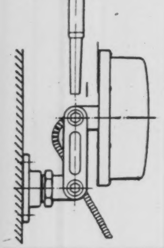
now in three types to suit any requirements



1

Rigid Stem Dial Thermometer

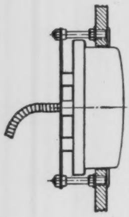
Rigid stem tapered bulb, interchangeable with standard industrial thermometer separable socket.



2

Wall Mounted Dial Thermometer

Wall mounted dial thermometer with flexible connecting armor. Case adjustable to easy reading position.



3

Flush Mounted Dial Thermometer

Flush mounted style for panel mounting with flexible connecting armor.

All three types have a full 4½" dial Face

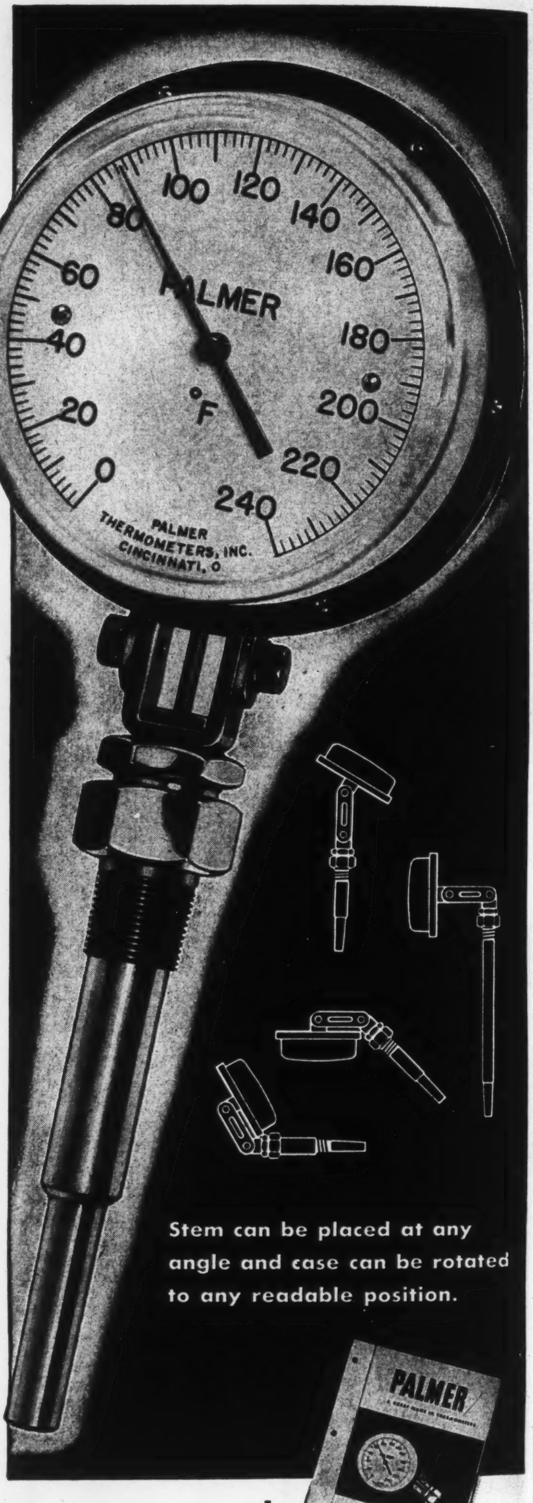
---

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensation. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

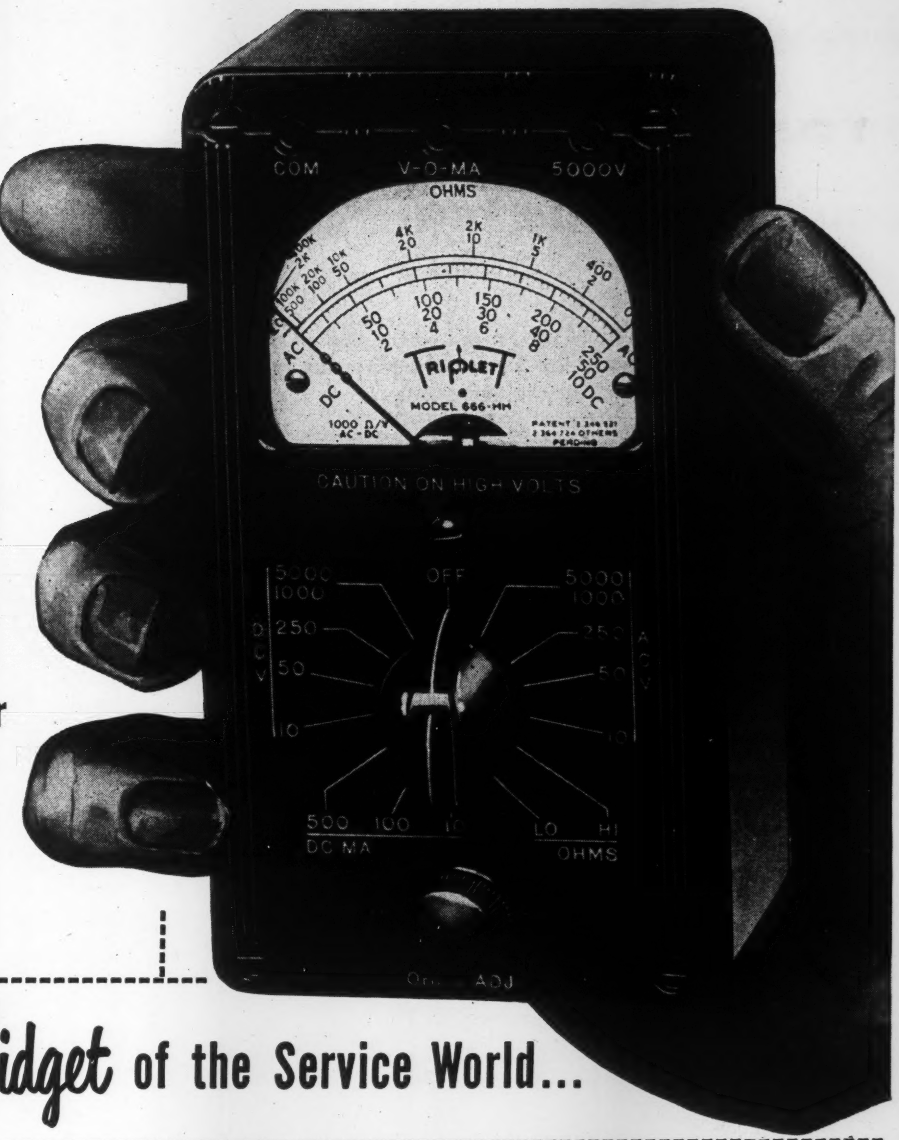


Stem can be placed at any angle and case can be rotated to any readable position.

SEND FOR THIS BULLETIN
For details on the New Palme
Dial Thermometer, please writ
for Palmer Bulletin 51-129.

PALMER

THERMOMETERS, INC.
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers
251 NORWOOD AVE., CINCINNATI 12, O.



ACTUAL SIZE

Model 666-HH

TRIPLETT

Volt-Ohm-Milliammeter

Mighty Midget of the Service World...

RANGES

D.C. VOLTS: 0-10-50-250-1000-5000, at 1000 Ohms/Volt.

A.C. VOLTS: 0-10-50-250-1000-5000, at 1000 Ohms/Volt.

D.C. MILLIAMPERES: 0-10-100-500, at 250 M.V.

OHMS: 0-2000-400,000 (12-2400 at center scale).

Slip this little V-O-M in your pocket and you become a walking laboratory for making complete D.C. and A.C. Voltage, Current, and Resistance Analyses. There's nothing "little" about this miniature marvel but its *size!* It's the mighty midget of the Service World—Truly a giant in performance.

Some of the things you get: a 3-color scale for quick-glance readability, only one switch for noticeable ease in correctly getting your range, the banana-type jacks that provide quick plug-in connections and lower jack contact resistance—and the remarkable stability on voltage ranges by use of special resistors throughout, and on current ranges with 250 M.V. instrument.

Buy Model 666-HH now—and remember, it carries the famous Triplett RED·DOT *Lifetime Guarantee.* Don't hesitate another day!

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

TRIPLETT ELECTRICAL INSTRUMENT CO., BLUFFTON, OHIO, U. S. A.

ONLY $24.50 AT YOUR DISTRIBUTOR

(Price Subject to Change)

even a surge to full atmosphere can't hurt this team . .

DPi has combined the thermocouple gauge and the Philips gauge into a single instrument that's low in price, requires no special operating precautions, and covers the entire range from 2×10^{-5} mm. to 1 mm. Hg on a single meter.

The combination circuit uses three readily available radio tubes and three selenium rectifiers. It operates from any 115-v a-c outlet. No panel adjustments are necessary. All the operator does is turn it on and read the pressure. It can be calibrated, if needed, from the outside of the 10″ x 8″ x 8″ cabinet. It's easily portable and requires no precautions against any pressure surges, even up to atmosphere.

The new Combination Thermocouple and Philips Gauge is one more step in DPi's continuing program to make high vacuum simple and inexpensive to create, measure, and use. We'll be glad to discuss your requirements in detail and quote specific prices. Simply write to: ***Distillation Products Industries,*** Vacuum Equipment Department, 765 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).

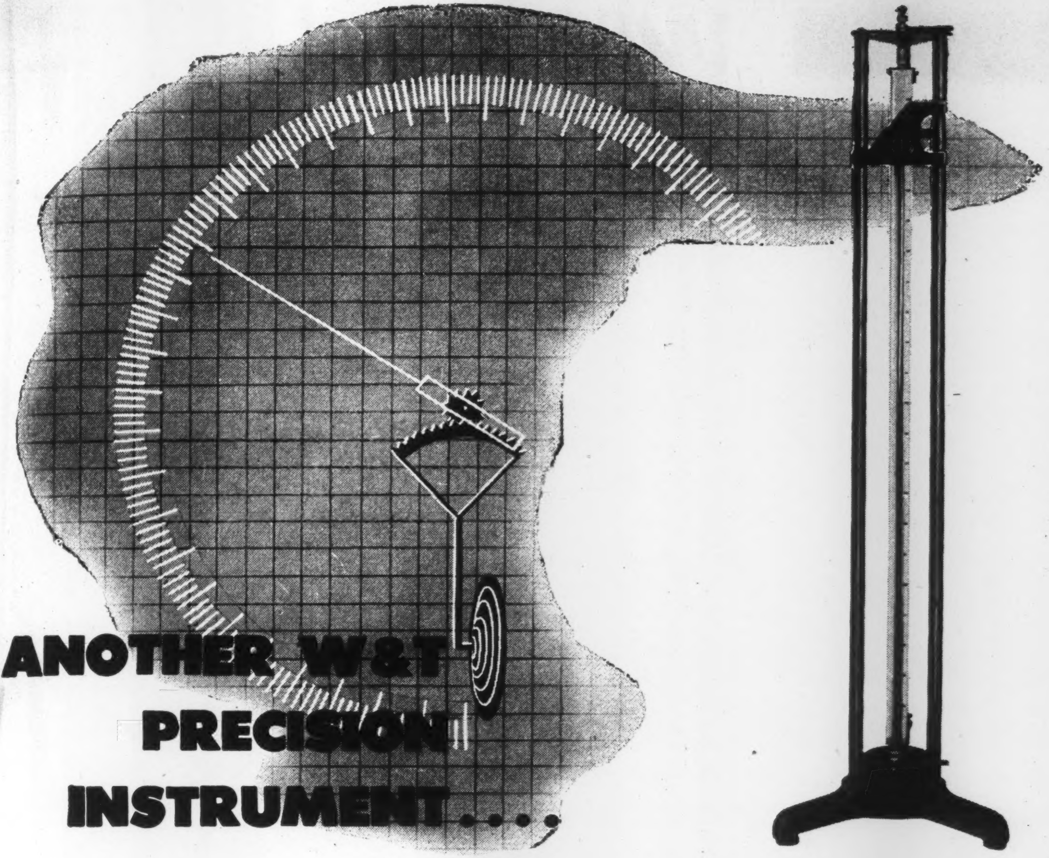
The Philips gauge tube *contains a loop anode maintained at 3-kv d-c potential and permanent magnets to compress the electron paths. Its positive ion current is a measure of pressure over the range from .02 to 25 microns Hg.*

The thermocouple gauge tube *contains a junction to which heat is supplied at constant rate. Its temperature depends on heat loss by gas conduction, and is therefore a measure of pressure. It covers the range from 1 to 1000 microns Hg.*

high vacuum research
and engineering

DPi

Also . . . vitamins A and E . . . distilled monoglycerides . . . more than 3400 Eastman Organic Chemicals for science and industry



The W & T Precision Mercurial Manometer

The W&T Precision Mercurial Manometer couples maximum precision with ease in handling. These two features have made it a leading instrument in modern research and manufacture for such uses as measuring sample pressures in infrared spectroscopy and calibrating aircraft altimeters. Because of its flexibility and accuracy, the Manometer can be used for almost any type of pressure measuring problem in the range of two atmospheres.

Such characteristics are only part of the picture. Take a look at these additional features:

1. Float type indicator eliminates difficulty in reading meniscus.
2. Adjusting knob provides for temperature compensation over a range of 30° C.
3. Precision bore manometer tube provides accuracy with interchangeability.
4. Fixed cistern type manometer requires only one reading.
5. Mercury sealed valve permits evacuating the tube simply and easily at the point of use.
6. Flexible design permits measurement of absolute pressure, gauge pressure, differential pressure, and vacuum.

For more details, write today for free technical bulletin TP-29-A.

WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
Belleville 9, New Jersey • Represented in Principal Cities

Calibration setup at Square D. Four Sorensen AC Line Regulators allow operator to concentrate on calibration procedures with assurance that line supply is a precise constant.

PRODUCTION UP 123%

——————— Through Isotronics*

That's the increase reported by SQUARE D's Los Angeles plant after installing Sorensen AC Line Regulators!

Square D Company, Los Angeles, manufactures circuit breakers. Calibration of these circuit breakers — adjustment so they will trip when a precise power load is imposed on them—is an important step in production.

Calibration equipment was powered from an unregulated line, and rejects at final inspection were running very high.

Square D engineers, realizing the source of the trouble, investigated various types of line regulators. It was essential that distortion be kept to a minimum and also that line regulation be precise; therefore Sorensen *electronic* type regulators were chosen.

Installation of Sorensen Model 500S AC Line Regulators cured the trouble, broke an important bottleneck, and, in this case, effected a production increase of *123%*.

Possibly in your plant there are situations where Sorensen line regulators or regulated DC power sources can cut costs and boost production. Write us fully — your problems will receive prompt attention.

*Isotronics is a trade-marked word pertaining to the electronic regulation and control of voltage, current, power, or frequency.

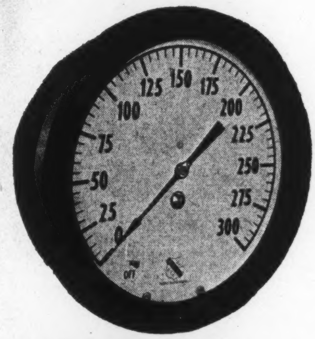
MODEL 500S

SORENSEN REGULATOR

FOR THE LATEST AND BEST IN ISOTRONICS . . .

Specify SORENSEN

SORENSEN AND COMPANY • 375 FAIRFIELD AVE., STAMFORD, CONN.



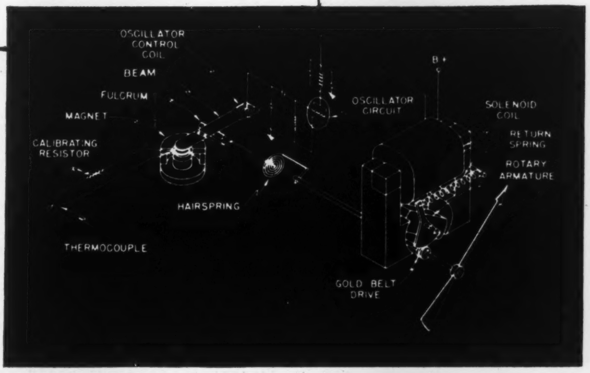
FACTS ABOUT THE NEW *American* ELECTRONIC TEMPERATURE MEASURING INSTRUMENTS

Conventional industrial temperature measuring devices, like millivolt pyrometers and potentiometers, are often too fragile, complicated or costly for many applications.

American Electronic Temperature Indicators and Recorders have none of these disadvantages, whatever the demands of service. They are rugged, simply constructed, economical–yet measure temperature precisely between –100° and + 3000°F.

Heart of the instrument is the power-actuated Microsen Balance, a unit extremely sensitive to low power input–insensitive to line voltage variations. Both dials and charts are readily calibrated to thermocouple temperature scales. Thermocouple cold junction compensation is achieved–regardless of ambient temperature effects–by a built-in, thermostatically-controlled and insulated heater. A sealed housing protects all measuring elements from dust and corrosive vapors.

The high torque rotary solenoid, which drives the pointer, makes the instrument especially suitable for round dial indication, thus reducing the opportunity for parallax error. It also assures "pin point" accuracy in positioning the pointer, and permits the use of dials as large as 12 inches.



HOW AMERICAN ELECTRONIC INDICATORS AND RECORDERS MEASURE TEMPERATURE

The Microsen Balance maintains equilibrium between two forces. One is proportional to thermocouple input, the other to the mechanical position of the instrument pointer.

Any change in thermocouple input deflects the Microsen beam and changes the proximity of the beam's flag end to the oscillator coil. The oscillator circuit then detunes and creates a current change through the vacuum tube and solenoid coil.

As the solenoid armature rotates, it positions the pointer so that the hairspring torque is opposed and equal to the input torque. The mechanical indication is thus weighed in exact proportion to thermocouple input. Consequently, the pointer accurately indicates the temperature on the dial.

MICROSEN BULLETIN 404 contains details about these revolutionary new temperature measuring instruments. Also included is information about American Electronic Indicators and Recorders for other fields of measurement. Write for a copy.

1850 AMERICAN U.S.A.

AMERICAN INDUSTRIAL INSTRUMENTS

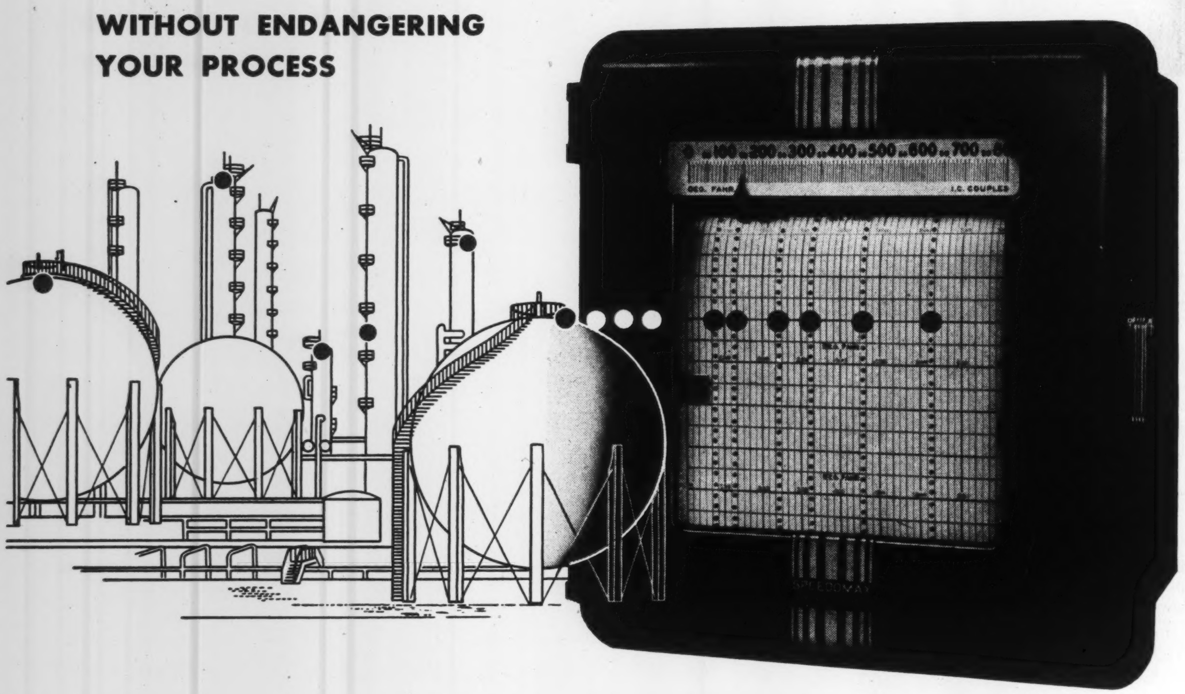
A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

HOW TO CENTRALIZE OPERATING DATA *and save money*

WITHOUT ENDANGERING YOUR PROCESS



In as little time as 2 seconds per point, Speedomax Multiple-Point Recorders centralize data about temperatures or other conditions scattered throughout process units.

Centralizing operating data from process units on one recording instrument pays off. It saves panel space. It lowers the recording cost per point. It warns of upsets in ample time for your men to act. It does all this . . . IF the instrument checks operating conditions frequently enough—fast enough.

With Speedomax Multiple-Point Recorders, you get not only the inherent savings in centralized data, but maximum information about critical process operations. At the fast rate of 2 seconds per point (or 3 or 4 seconds, if preferred), they can whip through as many as 16 or 20 similar variables in as little as 32 or 40 seconds. Where an extremely critical variable is involved, that point can be recorded more frequently than the others —in the sequence of 1, 2, 1, 3, 1, 4, 1, 5, etc.

In addition to this recording speed, other features give superior performance. A soundly-designed amplifier and electronic circuit assure unusual accuracy and sensitivity over range spans as narrow as 100 F. Instrument performance is unaffected by vibration. The quantity measured may be temperature, pH, speed, weight or electrical load.

The next time you want to bring temperatures or other data to a central point, make sure you do it safely . . . by getting the speed you need to guard against sudden upsets. Specify Speedomax Multiple-Point Recorders. For additional information about these instruments, just check the coupon and return.

LEEDS & NORTHRUP CO.

LEEDS & NORTHRUP CO.
4955 Stenton Ave., Phila. 44, Pa.

Please send Speedomax Catalog ND46.

Please send information about applying Speedomax Multiple-Point Recorders to..........

....

(Name) .... (Title)

(Firm) ....

(Address) ....

Jrl. Ad ND46-700(1)

Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Reflections *at the* End *of a* Year

IT IS fitting at the end of the year to pause and reflect a little about the accomplishments of the year past, the prospects of the year ahead, and the place one occupies in the general scheme of things.

Our country faces huge problems throughout the world. It is too easy to hurl accusations at political leaders, at economists, at military generals, at groups within our country, or at experts in any field—although they all share some responsibility for the unhealthy situation our nation faces. But most citizens of our great country are well-meaning honest men and women who do what they think best in each situation.

No matter what happens in 1952—peace or war—the key to the situation will be PRODUCTION. In peace, efficient production means a higher standard of life. In war, efficient production means survival. And no one group contributes more to efficient production than you—our readers—THE INSTRUMENT MEN. You research, design, and development men are the parents of instruments. You instrument manufacturers make it possible for the entire economy of our great nation to apply instruments. You sales and promotion men bring the instruments to the laboratories, to the schools, to the plants. You application men show how instruments make production ever more efficient. And you maintenance men keep the wheels turning 24 hours a day.

We of *Instruments* are dedicated to helping each of you. We report new developments, new instruments, new literature, new applications, and new ideas. For 24 years we have preached the essentiality of instruments, of instrument men, and of instrument manufacturers. We have been impartial in reporting all phases of our vast field—pneumatic, hydraulic, optical, chemical, mechanical, electrical, and electronic. We have preached that friendly competition is beneficial to all. That we are right is proved by the vast growth of the field.

In 1951 we brought you 97 feature articles. Our policy regarding articles may be of interest to you because it is based on your welfare primarily. We publish a feature article only when it first is presented to a technical society and then accepted by our own editorial staff or the editorial staff of the ISA or SCMA. The only exception to this policy is in the case of feature articles of special significance. Our policy protects you from articles written by a manufacturer who seeks only to describe his product. Yes, many manufacturers feel slighted because we reject papers which other magazines print primarily to obtain advertising from the manufacturer. Although this policy may lose some advertising for us, it has earned for us world-wide recognition of the high calibre of the technical contents of *Instruments*.

We reported 780 new instruments to you in 1951. If we missed a single one it was only because the manufacturer did not inform us of it—and few manufacturers anywhere in the United States fail to inform us of their new instruments.

We reported to you 1089 manufacturers' bulletins, catalogs, data sheets, and instruction books. Thousands of our readers have found the instrument they needed, or the solution to a problem, or the principles of a physical phenomenon in these wonderful publications. We classify the hundreds of publications so that each of you need waste no time in finding the publications you desire.

We gave each of you (except our foreign subscribers) the *Handbook of Measurement and Control*, a unique and remarkable achievement in the field. This handbook will accelerate the development of the entire field. We are now revising and expanding the *Handbook* so that two years from now you will receive a bigger and better *Handbook.*

We also gave you the *Instruments Index*, the most complete cross-index of instrument manufacturers and instruments in America. Every reader of ours need waste no time in finding any instrument or its manufacturer.

We are giving each of you who want to study electronics a down-to-earth rock-bottom home-study serial "Instrument Electronics." Several organizations have informed us that they are using this serial as a training course for their instrument men.

In our *Instruments on the March* department we brought to you 62 short features on new principles, new applications, and non-commercial developments in the field of instrumentation.

For 1952 we will expand every phase of your magazine. The calendar of events will contain all meetings of significance to instrument men—and will report on them far enough in advance so that any of you can make your plans to attend. You will receive more book reviews also.

It is no accident that *Instruments* Magazine is recognized by all outstanding instrument men and instrument manufacturers as the leading magazine in the instrument field. It is no accident that the largest manufacturers of instruments have *Instruments* Magazine at the top of their advertising schedule. This is a tribute not only to our work but also to the important positions which you readers occupy throughout industry and research. We have won our position by serving you, our readers. For 1952 we wish each of you happiness in your work. And we rededicate ourselves to making your work more efficient and more productive.

—MHA

ISSUES

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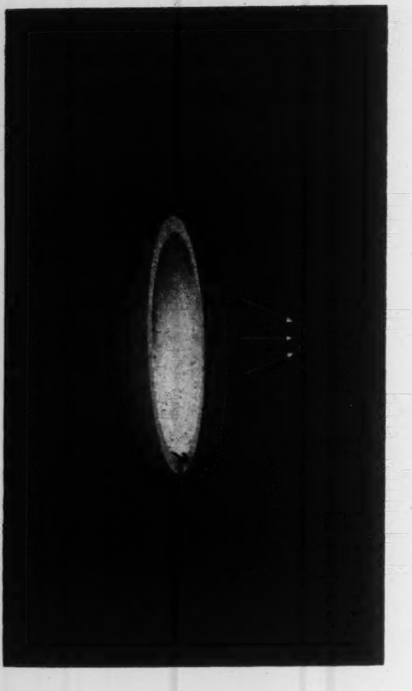
and thereby registers the end of the twenty-fourth year of *Instruments'* service to users of measurement and control devices—service to THE UNITED STATES OF AMERICA

The entire staff of *Instruments* wishes you

A Merry Christmas and A Happy New Year



Potential Importance of ULTRASONIC ENERGY to Industrial Processes

By J. W. BUTTERWORTH*

Power limitations, which have retarded industrial applications of ultrasonic energy, have been removed by modern ceramic transducers. Ultrasonic energy, transducers, and future potentialities are described in this significant article.

EXPERIMENTERS demonstrated the strange characteristics of ultrasonic energy more than 50 years ago. Since that time activity in the science of ultrasonics has accelerated tremendously. Today there is reported in the literature an almost limitless variety of accomplishments, including the disruption of pathogenic bacteria, acceleration of chemical reactions, flocculation, dispersion, emulsification, and many others, some of which are astonishing. Although most of these achievements represent valuable contributions to science, attempts to apply the experimental ultrasonic techniques to full-scale industrial processes have failed because available transducers could not generate the required ultrasonic power.

As a result of recent developments in the field of piezoelectric materials, there no longer exists the ultrasonic power limitations which previously frustrated large-scale exploitation of this potent energy. Transducers of modern design now have practically unlimited capacity for generating ultrasonic power; they can be made to concentrate their energy in liquids to intensities of several thousand watts per square centimeter. Ultrasonic energy is now a capable, industrial power, and is ready to be put to work.

The primary purpose of this article is to ascertain how big a job ultrasonics can be expected to do. Individual opinions may differ somewhat, depending on such factors as how well ultrasonics can be made to mix paint, degass liquids, clean materials, etc. However, some comparisons with familiar phenomena, and some answers to basic questions related to the nature, generation, and performance of ultrasonic energy may provide a means for evaluating the anticipated impact of ultrasonics on industry.

NATURE OF ULTRASONIC ENERGY

Ultrasonic energy is a physical phenomenon. It exists in the form of alternate pressure and rarefaction waves in elastic media, and is fundamentally the same kind of energy that we call sound. Its frequency range, however, is above that to which the human ear responds, and as the ear cannot detect it, one is at first inclined to think of ultrasonics as an entirely new and strange phenomenon. In some respects it is new and strange, but certainly the characteristics of the human ear do not make it so.

Although the ear is not a satisfactory ultrasonic instrument, its known performance can serve as a fairly good reference. Investigators have found that a sound power of 0.1 mw. per cm.^{2} in air has shattered the ear drum. Although an ear-shattering level might be classified as one of extremely high intensity, the ultrasonic intensity obtainable in the focal area of even a small modern ceramic transducer is more than ten million times greater.

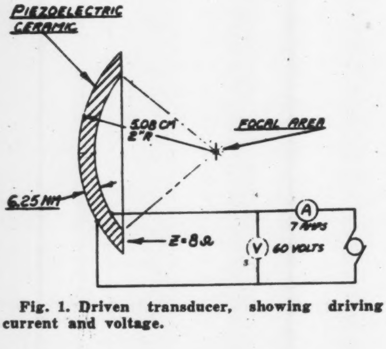


Fig. 1. Driven transducer, showing driving current and voltage.

Shown above is a ceramic transducer. It is a bowl-shaped piezoelectric element. As it is piezoelectric, its physical dimensions change when an electric potential is placed across its front and back electrodes. It is found that the ceramic material employed in its construction undergoes a change in thickness of 190 x 10^{-12} meters per volt. This material is elastic, and the bowl has a thickness resonance characteristic which can be computed from the millimeter-kilocycle constant of 2500. For example, if the bowl has a thickness of 6.25 millimeters, its thickness resonant frequency is 2500 divided by 6.25, or 400 kc.

POWER PRODUCED BY TRANSDUCER

Ceramic transducers of this type are designed to work in a liquid transmission medium. When immersed, they have an operating Q of 20 to 40. At resonance, therefore, the physical displacement for a given applied potential is 20 to 40 times greater than the off-resonance displacement. As the element works conservatively at a power of 2 w. per cm.^{2}, and has an area of 75 cm.^{2}, it develops approximately 150 w. of acoustic power.

By considering an area of 1 mm.^{2} in the focal region of the bowl, the theo-

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*Director of Hypersonics, The Brush Development Co., Cleveland, Ohio.

Presented before the Fifth Annual Convention of the Instrument Society of America, at Buffalo, N. Y., Sept. 18-22, 1950.

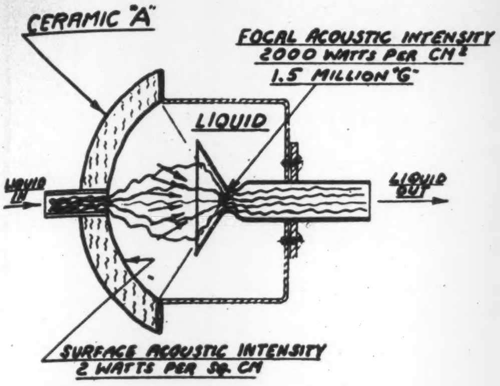

Fig. 2. Transducer developing high ultrasonic energy in flowing liquid.

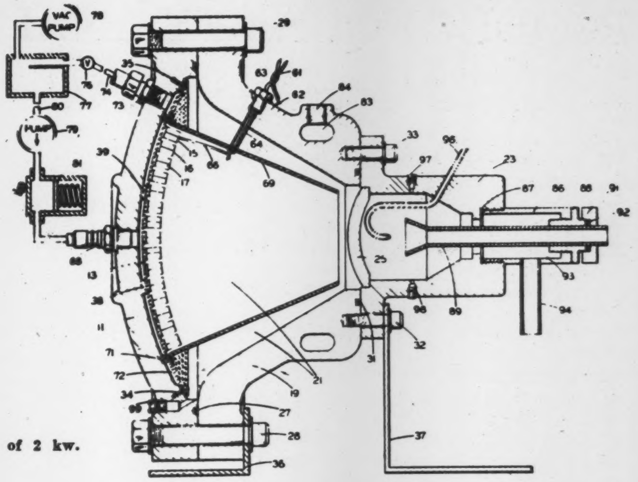

Fig. 3. 100-kc. transducer with rating of 2 kw.

retical intensity can be computed, and is found to be in the range of 6000 w. per cm.^{2} (Fig. 1). Owing to slight physical imperfections, however, and factors such as defraction and reflection, the actual measurable intensity was found to be in the order of 2000 to 4000 w. per cm.^{2}. A power of 1000 w. per cm.^{2} is ten million times greater than the ear-shattering level of 0.1 mw. per cm.^{2}

It is believed that 2000 w. per cm.^{2} in liquid at 400 kc. has not been achieved with any other type of transducer. Although this is important in terms of ultrasonic industrial applications, the true significance of this accomplishment lies in the fact that the focused element is a manufactured product made from readily available inexpensive material, and its configuration is one of a widely obtainable variety. Its size and shape were made to meet the requirements of a specific application. Discs, bowls, spheres, cylinders, and other shapes can be made with ease. The type selected will depend on whether point-focused, line-focused, uniform, or omnidirectional patterns are required.

REQUIREMENTS OF INDUSTRY

Keeping in mind that only a small laboratory transducer is being discussed, consider what 1000 w. per cm.^{2} means in terms of physical characteristics such as particle acceleration, dynamic pressures, and the like. If this focused bowl is set up in such a way that a continuous flow of liquid passes through the focal area (Fig. 2), the liquid will have exerted on it a 400,000-cycle alternating pressure of 1000 psi. If a contemplated industrial process requires high alternating pressures, 1000 psi. is a good level at which to start. Simultaneously with this alternating pressure, the liquid flowing through the focal area will have its molecular particles accelerated to more than one and one-half million times the acceleration of gravity. This, incidentally, is far greater than the acceleration developed by a modern ultracentrifuge weighing tons, which costs many thousands of dollars. If the contemplated industrial process requires high accelerations, of magnitudes associated with violent explosions, and if there is an advantage to having these accelerations repeated 400,000 times a second, then ultrasonics can be expected to do a good job.

Although the availability of a low-cost piezoelectric material which can be fabricated readily into a wide variety of shapes is an important contribution to the future success of ultrasonics in industry, it has little chance of success unless it can be shown that the available acoustic power is industrial in magnitude. In other words, the ultrasonic power must be in the order of kilowatts if it is to be expected to carry much of an industrial load.

PLANT-SCALE TRANSDUCERS

Some knowledge of what is now possible in the way of ultrasonic power generation can be had from an examination of the design and function of a 2-kw. pilot-plant equipment.

Fig. 3 shows a 100-kc. transducer which has a continuous operating rating of 2 kw. The active surface is a mosaic of approximately a thousand ½-inch hexagonal piezoelectric elements. They are fastened to a perforated concave bowl in such a way that their extended axes converge at a point one foot from the bowl's surface. This means that the acoustic power generated at the surface of the elements is directed toward a focal area. If laboratory experiments establish that a given process can be accomplished with ultrasonic intensities of 20 w. per cm.^{2}, the processing area can be located between the focal point and the mosaic surface at a place where it will be approximately 650 cm.^{2}; the available work area at 20 w. per cm.^{2} will be 65 cm.^{2} or approximately 10 sq. in.

In order to deliver the acoustic power at the work area with maximum efficiency, certain precautions must be taken. The transmission liquid medium must be carefully treated and degassed. Castor oil, which is normally employed for this purpose can transmit, at atmospheric pressure, approximately 3 w. per cm.^{2} Power intensities greater than this at one atmosphere cause internal negative stresses sufficient to tear the liquid apart, and cavities are formed.

As ultrasonic energy cannot pass readily through cavitated areas, cavitation must be prevented, at least until the energy has reached the working area. This is accomplished by increasing the static pressure to several atmospheres, and by circulating the oil through the elements and in the direction toward the focal point. It has been found that cavitation requires a finite time to occur, and a continuous flow of the transmission medium through the high-energy areas greatly minimizes cavitation.

Considerable heat is generated because of mechanical and electrical losses. To avoid overheating of the piezoelectric elements, provision has been made for cooling the circulating oil. Means have also been provided to compensate for changes in pressure resulting from temperature expansion of the oil.

FUTURE APPLICATIONS

The ultrasonic system described is a first important step toward the goal of widespread use of ultrasonic power in industry. It has a 2-kw. rating only because 2 kw. seemed like a good starting place. It could have been 5, 10, or even 50 kw. if these higher power levels would have served better as a practical demonstration. The 2-kw. unit is now undergoing final severe performance tests intended to prove that it is free of weakness and is ready for a place among other industrial machines. Applications in industry for the 2-kw. units are ready and waiting. We will soon be looking for 50-kw. applications. When they are found (we hope in the very near future) the importance of ultrasonic power in industry will cease to be potential—it will be actual.

PRODUCT QUALITY ANALYZERS —*NOT* a "Must" in the Oil Refinery

By J. A. PELLETTERE and R. L. PATTON, Gulf Oil Corp., Pittsburgh, Pa.

IN this day of push-button automatic control, it might sound backward to suggest that product analyzers of the continuously indicating, recording, or controlling type are not necessarily a boon to the oil refinery.

If the industry is to adopt the use of these instruments, it expects some return for the higher initial investment in instrumentation and for the materials and wages expended in upkeep and calibration. This return must be tangible as either more product or higher-quality product commanding a higher price; or it must reduce some item now charged off as a loss.

PRODUCT QUANTITY

An oil refinery unit, or a still, is basically a bulk liquid product plant of large capacity, operating continuously for long periods at constant load. Most stills run for periods of six months to a year before shutting down for inspection and maintenance work. On-stream time usually exceeds 90 percent, and for many units it is 95 percent or better. Substantial investments are made in alternate equipment such as standby pumps and bypassing arrangements to permit emergency repairs while in operation. Anything which enables longer runs on stills must obviously come in the form of improvements to basic equipment—pumps, exchangers, heater tubes, vessels, piping, valves, etc.—or in better ways of preventing corrosion, erosion, and related problems. It is the authors' belief that product-quality analyzers cannot offer anything toward lengthening a still run or reducing the period of shutdown.

Can a product-analyzer instrument contribute to a higher throughput? The answer probably is no. Stills are usually up to 100 percent of design capacity within a few days or a few weeks after construction is completed; they sometimes are pushed to perhaps 120 percent of design capacity. To attain these figures, some bottlenecks must be eliminated—a larger valve here, a new section of larger pipe there, perhaps a new design for fuel burners or additional heat exchangers. But once a reasonable maximum has been attained, the still operates at that peak load continuously, except for short periods at the beginning and end of a run and in times of upsets, which are caused usually by failure or malfunction of some of the basic equipment. The instruments now in use have proved themselves adequate for operation at present capacities.

PRODUCT QUALITY

Consider product quality. Aren't product quality analyzers designed to watch over our product streams tirelessly, to insure that they never deviate from specifications? Let's take a good look at this one.

How often do we now produce anything seriously off-test? No savings are available the first day of a new run, when we are coming up on stream and establishing temperatures, pressures, and flow rates. When somebody "goofs off" (opens the wrong valve and dumps gasoline into a fuel oil tank) or when some equipment fails to perform properly (perhaps an instrument), will these new instruments prevent this or be any less likely to fail than our present instruments?

But what about those small discrepancies that creep in occasionally, resulting from variations in temperature of a degree or so, and from similar minor inaccuracies? Admittedly, these now and then throw product streams outside of acceptable limits. We continually check samples in the laboratory, once a shift or oftener, and frequently are able to take corrective action before the contents of any entire product tank fall below par. If the error is not caught in time, that tank usually can be blended off with another tank which may be slightly above par on the particular test involved so that the net product is within the required tolerance. As most finished products are a blend of several intermediate products, any such temporary lapses result at worst in a slight adjustment of blending ratios.

Suppose an occasional tank of a product is too far from specifications to retrieve by blending. Aside from the primary cause mentioned above—start-up losses—the total of all such mishaps is a negligible percentage of the aggregate. And they are not a total loss because they can be reclaimed practically 100 percent by rerunning.

COMPARISON WITH A BOILER HOUSE

A steam generating plant, or boiler house, might be compared with an oil still. Both operate for long periods between shutdowns and both produce a continuous stream of fluid product utilizing basically similar equipment—heaters, pumps, piping, drums, and valves. Instrumentation for a modern automatic boiler, however, is normally more complex and expensive than that of a modern still because of this important difference—the boiler usually operates under a varying load in accordance with demand for steam, whereas the still operates day after day at a steady high rate.

Boiler instrumentation is elaborate and costly because under changing load conditions several functions must be controlled closely. Fuel rate must be increased or decreased to maintain header pressure to meet the demand. Feedwater rate must be controlled to keep drum level within fairly close limits. Ratio of air to fuel must be reasonably constant to avoid stack losses; and furnace draft must be maintained so that fires do not leave the furnace and blow out into the room.

Stack losses due to inefficient combustion represent a definite, irretrievable loss in fuel; stack gases cannot be rerun to salvage the wasted fuel. Flue-gas analysis has long been the accepted method for determination of these losses and the basis for corrective measures. But, although various types of gas analyzers have been on the market for many years, few serve as automatic controllers of fuel-air ratio; the hand Orsat has not been eliminated.

CONCLUSION

Automatic control is needed in the oil refinery to take care of minor load variations caused by such things as changing fuel-stock temperatures or composition, slight irregularities in steam pressure, and gradual changes in pressure drops caused by accumulations of sediment or foreign materials or by erosion. Control instruments are needed also to help the operators in times of upset, as otherwise a man might need to be in sixteen places at one time, instead of only four or five. And the indications or records of the instruments are needed to assist in diagnosis of trouble, and to help keep the production of off-test material to a minimum.

To sum up: Quality-control instruments of the laboratory-analysis type, in order to justify added complexity and cost of instrumentation, must show a profit if oil refineries are to adopt their use. As they cannot increase still capacity rates or length of time between shutdowns, and as they cannot materially improve product quality, it follows that these instruments must reflect a saving in some item now charged as expense.

It is unthinkable that our laboratories can be dispensed with entirely. It is possible that the personnel in the laboratory might be reduced, but almost certainly at the expense of enlarging the crew of instrument technicians. As rerunning of off-test products is already at a practically irreducible minimum, where is the saving to occur?

The oil industry did not reach its present state of development without a tremendous amount of experimentation with the ideas of its own people and those of others; it will spend many more dollars in the same way. It will buy a few of the new instruments as they become available—if they seem to have merit—and it will give them a fair and unbiased trial. When their cost and maintenance promises a reasonable return on investment, it will whole-heartedly convert to the super-analyzers. Until then, it will remain reserved in enthusiasm for automatic product-quality control.

PANEL DESIGN

By R. L. HURLEY, Jr.,
E. I. duPont de Nemours and Co.

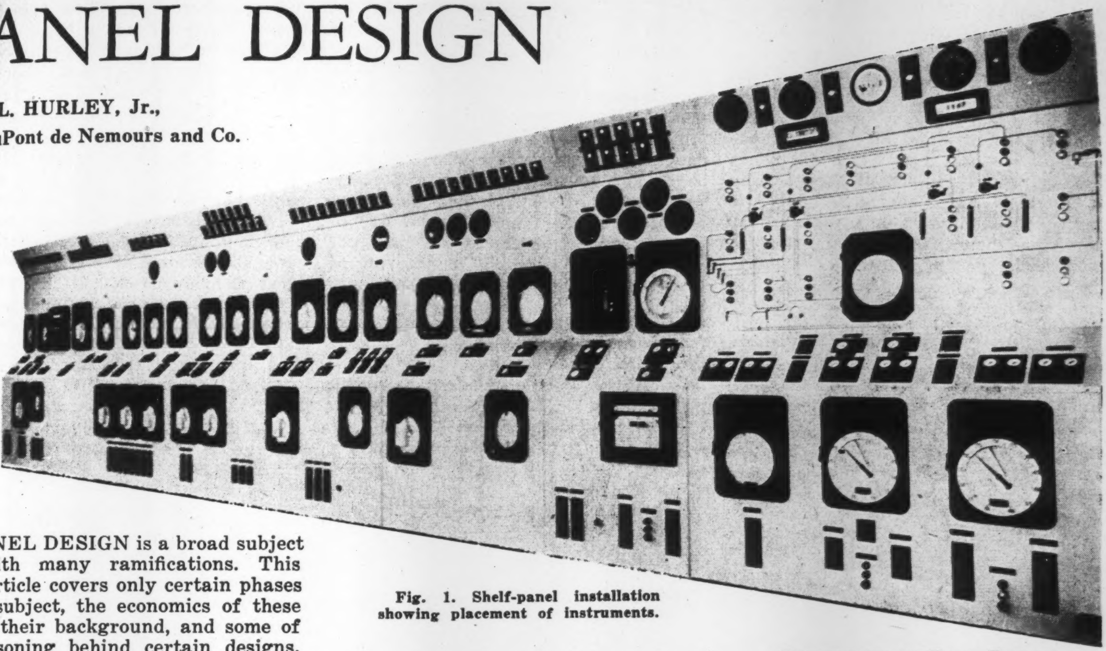

Fig. 1. Shelf-panel installation showing placement of instruments.

Background and development of modern panel design and standardization by the duPont Corporation. The conventional flat panel, the standard shelf panel, and the graphic panel are described in detail, including standards for finishes, auxiliary braces, wiring, and piping.

PANEL DESIGN is a broad subject with many ramifications. This article covers only certain phases of the subject, the economics of these phases, their background, and some of the reasoning behind certain designs. One statement on panel design can be made without controversy. This statement is that the most economical design in panels is one that can be continually duplicated. Unfortunately, however, repetition is impossible because of various factors. An attempt has been made by duPont to standardize on panels. Some standardization has been accomplished and considerably more is contemplated. This article does not attempt to show every design now in use on panels because most panel design depends on the process. Only those phases of panel design that have been more or less standardized are discussed. Although some of these are controversial, they fill a need in the field and are introduced with the hope that they will stimulate discussion.

Not many years ago, instruments were installed because the operators insisted on process evaluation, or because they were an absolute necessity for the determination of a variable. Little consideration was given to the economic benefits that could be derived from instrumentation. This was due partly to manufacturers' lack of knowledge of the problems involved and to users' ignorance of the benefits obtainable by instrumentation. Both these factors have been eliminated gradually, and instrumentation has proved to be even more beneficial than originally anticipated. The field of instrumentation has grown rapidly, as have the problems that accompany rapid growth.

Some years ago, a multimillion-dollar plant was designed and built. Although the base cost for instruments exclusive of installation was about $350,000, little consideration was given to the fabrication or location of panels for the job. Panels were fabricated from materials available on the plant site and located on a basis of the capillary lengths. The result was excessive maintenance cost. Fig. 2 is an example of an early panel.

The advantage of well-engineered and prefabricated panels was hard to prove. No records were available to prove the economic advantage of prefabricated panels over "field"-fabricated panels. It was only after a few trial installations that facts were obtained to prove that prefabricated panels were labor-savers, were practical, and gave a finished appearance to the job. At present, few instrument personnel are opposed to prefabricated installations. The greatest problem is finding qualified fabricators.

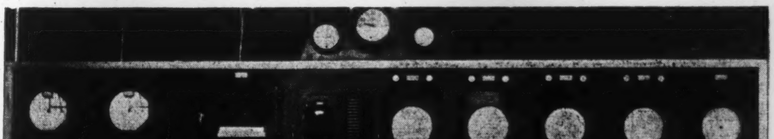

Fig. 2. Example of an early panel.

CONVENTIONAL FLAT PANEL

The conventional flat panel now utilized by the duPont Company has been standardized, but only after considerable study and investigation. The term "conventional flat panel" is applied to a panel built of a flat piece of material such as wood, steel, or composition sheet. This type of panel has no indentations or appendages added to the face of the panel. The instruments on it are more or less standard types that have been in use for a number of years.

Width.—The first standardization was due entirely to the restrictions placed in sheet steel during World War II. It was decreed that the width of sheet steel should not exceed 48 inches. Consequently this restriction applied to instrument panels made of steel. The original width was used in its entirety and angle bracings were made for support of the sheet. Thus the first attempt at standardization was with 48-inch panels. This type of panel construction was costly and proved unjustified. After extensive study, a 44-inch standard was adopted by the duPont Company.

An investigation was conducted on the most commonly used instruments in the chemical field, and it was found

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Presented at the Third Annual Symposium on the Philosophy of Panel Design, New Jersey Section, ISA, April 3, 1951, Newark, N. J.

that two of the largest instruments could be placed side by side on a 44-inch-wide panel. This width allowed a 2-inch flange to be bent without the necessity for adding anything to the original 48-inch sheet received from the mill. On the other hand, to increase the panel width from 44 to 48 inches obviously does not permit the addition of another instrument. Secondly, to use the 48-inch sheet as a panel width requires a mounting frame and thus increases the cost of material and labor. On the basis of this reasoning, the 44-inch width was selected as a standard for the conventional type of panel.

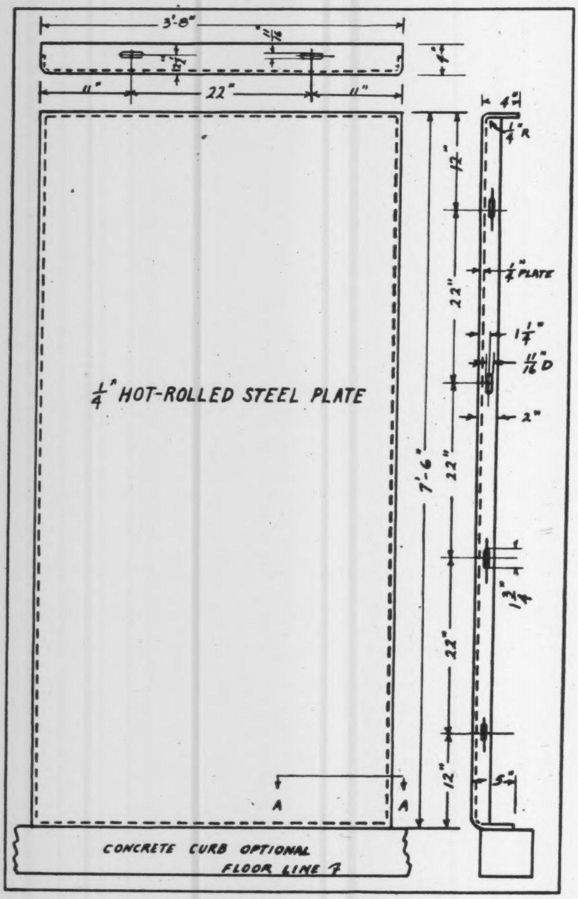


Fig. 3. Gage-board panel-blank.

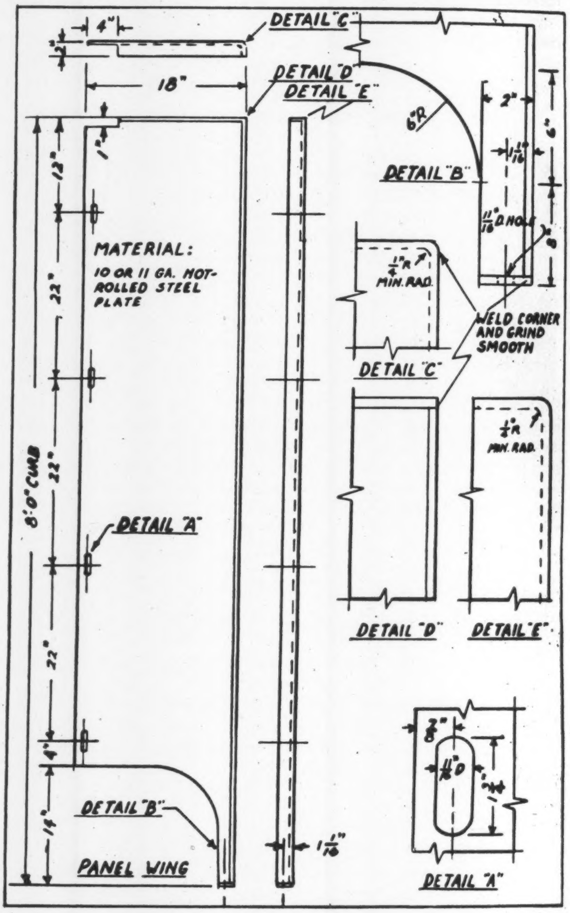


Fig. 4. Panel-wing details.

Third—and this will astonish a few readers—it was found that approximately 10 percent more instrumentation could be installed on a multiple-panel installation using 44-inch panels than on one using 48-inch panels. This is because more 44-inch panels than 48-inch panels can be installed in a control room of a given size. This results in an increase in the number of instruments mounted, considerable savings in control-room cost, and no sacrifice in the proper installation of instruments. On the basis of the facts cited, the 44-inch width was selected as a standard for conventional flat panels.

Height.—The next consideration given to standardization was that of height. A study was made on various types of design in use at the time. These designs had good and bad features, but none seemed to meet all the requirements. It was determined that the optimum vision line was 5 ft. 3 in. from the ground. Using this as a starting point, the lower instrument-chart centerline was found to be 3 feet. This dimension was determined from (1) the size of the instrument in use at the time and (2) the average height of the line of vision of a normal person. Also, this height allows the mounting of two of the largest instruments vertically with space between them for accessory equipment. The heights 5 ft. 3 in. and 3 ft. are now being used successfully as chart-center mounting-lines. They provide the basis for determining the over-all height of the panel.

Over-all height.—The over-all height of the panel must (1) conform to standard practices, (2) be economical, and (3) take into consideration the parallax factor without wasting panel space. This problem was studied by the duPont Development Group. An over-all height of 7 ft. 6 in. was calculated for the panel. This height was the highest that could be built economically and allow for the installation of the largest quantity of instruments. On a panel which has a width of 44 in. and a height of 7 ft. 6 in., it is possible to install four major instruments, two above each other, with the remainder of the panel at the top available for the installation of at least two rows of gages or visual alarms. The parallax factor was considered and it was found that with the heights of the chart lines as given above, it was possible to minimize parallax. The height of 7 ft. 6 in. has taken into consideration situations where a panel must be mounted on a curb. The height of the curb was determined to be approximately 6 inches. Consequently the over-all height from the floor when the panel is mounted is on a 6-in. curb is 8 ft. In summary, the standard flat panel has a width of 44 in. and a height of 7 ft. 6 in. The side flanges are 2 inches wide, the top mounting flange is 4 inches, and the bottom flange is 5 inches wide (See Fig. 3).

Single panel.—The 44-inch width is, of course, for the installation of two instruments side by side. If only one instrument is to be mounted, it was agreed that a single-type panel should have all the construction details of the double panel but be 22 inches wide. This allows replacement of one double panel with two singles, or vice versa. This arangement has proved practical and economical.

All panels of the conventional type are not either 22 or 44 inches in width. These standards have been in use only since 1947, and a considerable number of panels were built prior to that date. In some situations, space limitations and economic factors have required that panel widths be increased. However, the construction details have not been altered in most applications. No standard is of any value if it is not flexible.

The standards for the conventional flat panel were derived in 1947. Since that time considerable progress has been made in panel design. Panel design has kept pace with instrument design. The flat conventional panel is not obsolete and probably never will be, but considerable changes have been made in its design to meet new process and instrument designs.

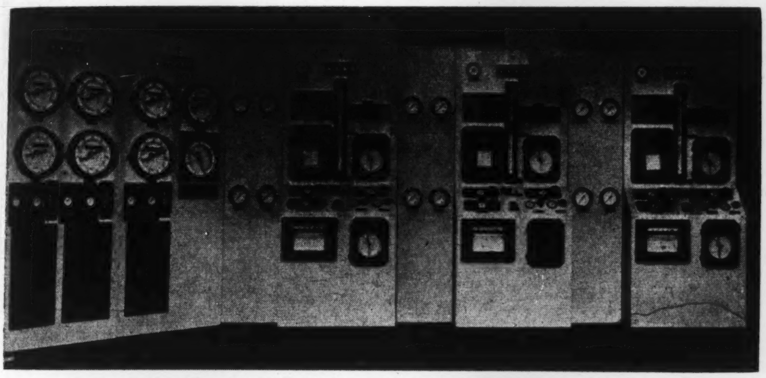


Fig. 5. Panel-board installation using standard flat panels and shelf panels.

STANDARD SHELF PANEL

The use of more centralized control rooms, and the utilization of these rooms more efficiently, meant more instrumentation and accessories. As these additions were mounted on panel boards, it was found that the flat conventional panel was gradually proving inadequate. The instrument engineer was thus forced to look for better designs in panels. The outcome of this was the development of the standard shelf panel.

The standard specifications for the conventional flat panel were retained where practical, but a number of alterations had to be made to meet new requirements. The height of 7 ft. 6 in. was retained because this does not entail problems in fabrication and allows the use of conventional flat panels alongside the shelf type, as in Fig. 4. The normal vision line was retained for the same reason.

The panel height of 7 ft. 6 in. was divided into three sections—bottom, shelf, and top. The first shelf panel developed proved practical with the exception that the shelf was too high. This shelf was approximately 40 inches from the floor and inconvenienced the operator. Therefore, a panel was fabricated which had a bottom section 3 feet high. This made the shelf at approximately normal operating height for an operator who was standing. The shelf was made on an angle that gives maximum vision without protruding in the rear far enough to conflict with the upper or lower instruments. It was determined that optimum arrangement of this shelf is an angle of 45 degrees with a height and depth of 12 inches. This leaves 3 ft. 6 in. for the top section (Fig. 5). This arrangement is satisfactory for specific installations.

Care must be exercised in placing instruments on the shelf-type panel. Critical instruments should be placed on the top-section panel for visual reasons. Auxiliary equipment, such as automatic to manuals, remote loaders, pertinent electrical switches, etc., should be installed on the shelf. The equipment on the shelf generally is operated manually by the operator and should be in the most accessible place. Extreme caution must be used to prevent this equipment from being accidentally operated by someone leaning or touching the shelf section of the panel. Instruments used mainly for recording generally are located on the bottom section.

The shelf-type panel lends itself to graphic interlock layout, both pneumatic and electrical. The graphic or flow interlock diagram can be mounted on the top section, and the lighting and alarm panels can be mounted in their respective positions on the flow diagram. This is in line with graphic-panel design recently developed. The shelf can be utilized mainly for manual operating switches and the lower section can be devoted primarily to recorders, as shown in Fig. 1.

The space above the upper instrument level of the panel board can be occupied by indicating instruments that do not require manipulation. This extra space can be used also for alarms.

GRAPHIC PANEL

The most controversial design in panels today is that of the graphic panel. This panel does not lend itself to standardization, but since its conception in 1947 by duPont, considerable effort has been expended to standardize it. Although this effort has resulted in some standardization, much work is yet to be done.

There are two schools of thought on the graphic panel. The first is exemplified by a problem presented to the writer at a Design meeting in 1947. The operating personnel for a specific process were to be hired on the site and, consequently, would not be familiar with the process. It was decided to bring the process to the operator. When this approach was presented to a leading manufacturer, one engineer and a designer were assigned to work with the writer. The ultimate result was the forerunner and example for the much publicized Rock Island graphic panel (Fig. 6).

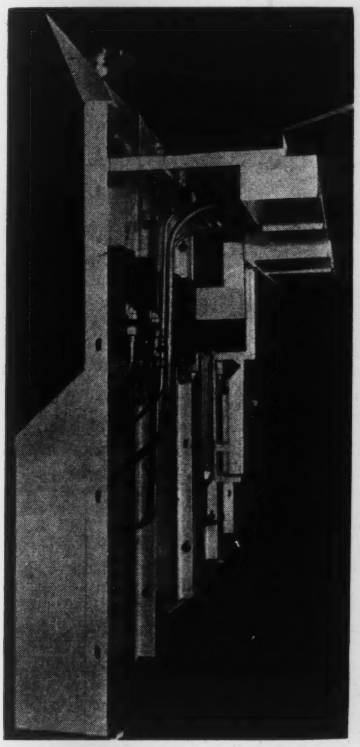


Fig. 6. Side view of standard shelf panel.

The second school of thought arose with the installation and operation of the aforementioned panel. This panel was considered confusing in that it tried to show all the operational equipment along with the attendant controls. The result has been to show only major operational equipment with its controls and to disregard elevations, etc. (Fig. 7). These two schools of thought have made it rather difficult to standardize on graphic panels to any extent. However, the standardization program has made some progress on graphics—for example, variable standards, process equipment standards, and process line standards.

To what extent can this standardization be carried? There is no limitation to the extent of standardization if prejudice can be overcome and replaced with logical thinking. The following ideas have been advocated:

(1) All storage tanks should be mounted on a straight line at the base of the graphic panel. This would facilitate the wiring of level alarms and piping to the Panalarm.

(2) All feed-pump symbols should be shown directly above the storage tanks in a straight line with the associated tank.

(3) All major operational equipment such as stills, furnaces, vaporizers, etc., should be located in the center of the panels with appropriate auxiliary equipment located in their approximate elevation.

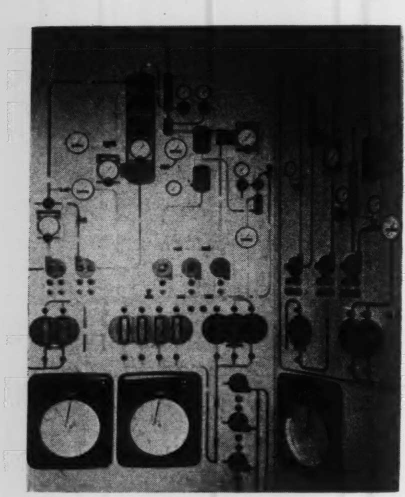


Fig. 7. Graphic-panel installation.

This arrangement would allow the graphic section of the panel to be installed in the center part of the panel, with recordings and other necessary operating equipment located at the base of the panel board.

FINISHES

The problem of finishes was referred to the department best qualified to solve it. The Finishes Division of duPont conducted a survey in conjunction with their Color Conditioning Program and recommended the use of a light shade of blue, grey, or green.

The Electrical Group then was asked to study the three colors recommended in conjunction with their study of panel lighting. The well-known duPont green was selected because of its natural appearance under fluorescent lighting.

The next question was whether to use Dulex or Duco finish. Two prerequisites were set down for the finish. First, the panel paint should be capable of being retouched without much trouble. Second, the paint should dry quickly. The results of these two prerequisites led to the selection of Duco. The choice of green Duco finish as the standard finish for the panel was then turned back to the Finishes Division, which wrote up a complete specification for this finish. These specifications created some problems with the fabricator, but are now considered adequate and practical. Other manufacturers also are using this finish.

AUXILIARY BRACES, WINGS, AND APPENDAGES

The panel thickness was considered carefully. The ultimate objective in panel design is to get the most economical panel suitable for the purpose. Based on this objective, the best panel thickness was determined to be ¼ inch. This thickness was based on the fact that considerable strength is required after numerous cutouts are made for instruments. Secondly, the use of the ¼-inch panel has eliminated the extra bracing that would otherwise be required for strength. The elimination of extra bracing has proved to be economical also with respect to the piping and wiring of the standard panel.

When cutouts are numerous, the back of the panel is crowded. In some cases the panels are so crowded that auxiliary control equipment cannot be installed on the back of the panel. This condition has required use of WINGS. These wings are attached to the side mounting flanges of the panels and serve as auxiliary panel space for mounting alarm switches, blind controllers, Standatrols, etc. The design of these panels is comparatively simple and the construction is shown in Fig. 8.

WIRING

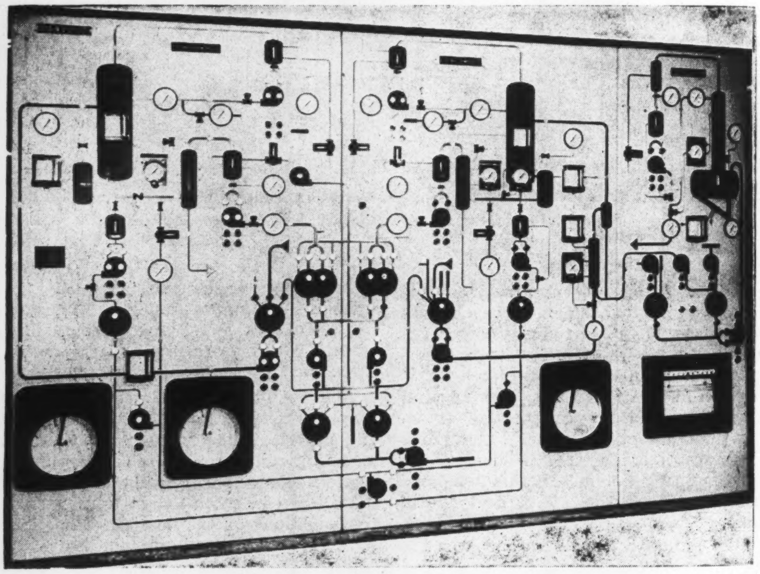
The wiring of any panel depends on the instruments on the panel and the operating conditions. Several things common to all panels are listed as follows:

1. No power supply is greater than 110 volts.
2. Each panel has its own power supply.
3. Each instrument is wired for independent shutdown.

The first item is important for safety. The panel is usually the responsibility of the Instrument Department and no instrument mechanic is considered qualified to handle voltages higher than 110 volts. Secondly, the wiring is simplified by not using higher voltages.

The second item was added to the general specifications after some rather expensive shutdowns were experienced because of electrical failures. Separate power supplies are justified on the basis that failure of one panel does not affect other panels. Secondly, the trouble can be found and remedied more easily if only one panel is out of service at a time.

The third item is self-explanatory because each instrument must be disconnected for removal from the panel. The safety factor enters again because no mechanic should work on "hot" lines. Also, savings on charts are realized because the instrument can be removed from service. In regards to item 3, it has been found practical to install a fusing plug (now being more or less standardized in the duPont Company).



Fg. 8. Simplified graphic-panel installation.

Fuse plug.—The fuse plug is a twist-lock type of plug which is attached to every panel instrument requiring electrical service. The plug contains a fuse, which precludes the possibility of putting an entire panel out of service because of failure of the electrical system of an instrument. Use of the fuse plug permits a common power supply to be used for the entire control room. The fuse plug protects the common power supply from instrument failure. Consideration is now being given to the use of this type of a plug as a standard on all panel boards installed in the duPont Company. (Fig. 9).

Where interconnected wiring is essen-

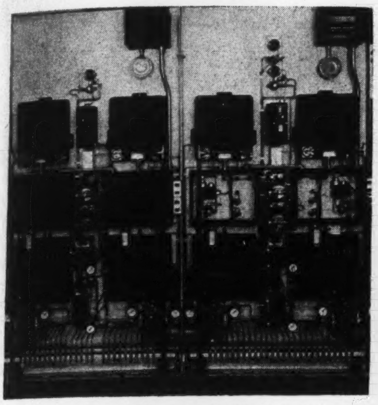


Fig. 9. Rear view of a standardized installation.

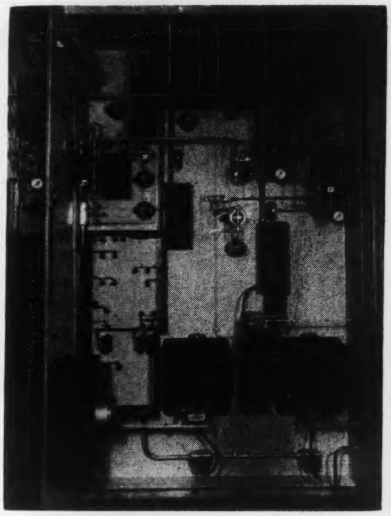


Fig. 10. Rear view of a standardized installation showing fuse plugs.

tial, such as where one actuator is on one panel and another unit of the same system is on another panel, an electrical safety interlock system should be used. It is not possible to standardize such systems because the chemical industry does not duplicate its processes and instrumentation. Therefore, specifications vary with each type of design.

PIPING

Although the methods of piping a panel depend on the equipment being used, considerable uniformity can be made. Some standardization has been accomplished and the result has eliminated much confusion. For example, the air supply on each panel is considered as a separate unit and has an independent air supply with its own isolating valve. This permits the panel to be out of service without affecting the supply to the other panels. The individual supply to each instrument also has an isolating valve to facilitate removal of a single instrument from service. As the main air-supply header to all panels has full compressor pressure on it, the pressure must be reduced before being used by the instruments. A ½-inch or a ¼-inch reducing valve can handle all the users on one panel. Unfortunately, however, all manufacturers do not use the same air-supply pressure requirements.

Wherever possible, several instruments are supplied from one air reducer, and independent supply lines branch off after the reducer. The instrument isolating valve is located on these independent instrument supply lines. Where the instrument cannot be removed from service without seriously affecting the process, two air reducers are used in parallel. This permits one reducer to be repaired without putting the critical instrument out of service. It is now common to have one air reducer of an exceptionally good make control the main air-supply system to a control room. This reducer has another in parallel in case of failure of the first. Economically, this has produced savings.

The loading pressure line from the instruments generally is of uniform size, and standardization from the instrument to the terminal rack may vary with the location of the actuated element. These lines can terminate at either the base or the top of the panel. If termination is at the base, an angle-iron support is attached to the panel for mounting all the terminals in an orderly fashion. This bracket is used also for mounting the nameplates of the actuated elements. All tubing from these elements is brought up through a sleeve or trough through the floor and connected to the proper terminal. This not only eliminates the possibility of error or confusion during construction, but also facilitates maintenance. Sometimes the sleeve or trough is attached to the panel as a permanent fixture. For lines which terminate at the top of the panel, the same procedure is followed but, instead of a sleeve or trough, a tray is attached permanently to the top of the panel (Fig. 11). This tray is made of 16-gage steel with a 3-inch back flange. When all panels are bolted together, the trays form a runway for supported tubing. The tubing is run in the trays and then branched off to its proper connection. This facilitates the running of tubing from the process to the panels in the same manner as for the lower terminal block.

The transmission lines from the variable are run in the same manner as the loading pressure lines. The only exception is that the same bracket that holds the terminals is utilized for supporting T valves so that test pressures can be applied to the receiving instrument without removing the instrument from the panel.

The most common type of tubing used is copper. In applications where copper cannot withstand the corrosive atmosphere in which the panels are located, the panels have been fabricated from aluminum, and the tubing is polythene-covered, polythene, rubber-covered, or stainless steel. The use of these materials increases the cost of panel owing to cost of material involved, but the main cost increase is in labor.

The decision as to which type of panel is the best for any job depends on the process and the economics of the job. Each type has its place in the instrument field. The field of panel design has barely been scratched, and further study should be made to evaluate panel design and the savings realized. Where there is standardization, there are savings.

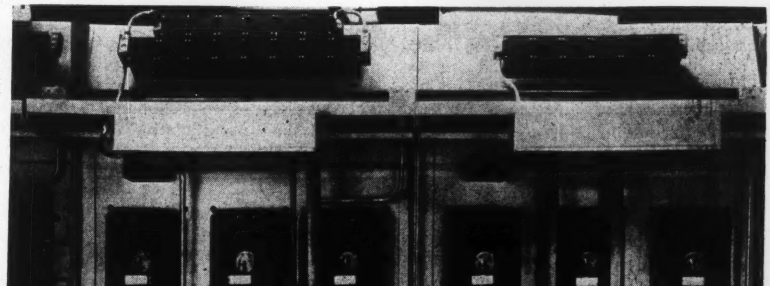


Fig. 11. Rear view of a standardized installation showing tray at top of panel.

PNEUMATIC OPERATORS
for
THROTTLING CONTROL

By DONALD P. ECKMAN*
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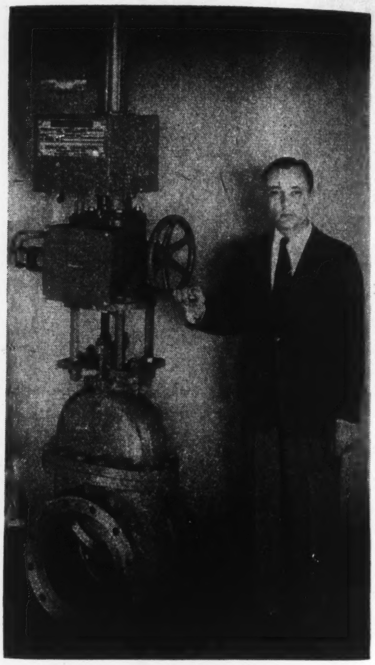

Dwarfed by "rotomotor"-valve assembly is "Cono" Production Manager Ralph G. Holben.

Analysis of the response and characteristics of spring-diaphragm, springless diaphragm, and springless piston valve operators shows the advantages of a new positioner which uses a pneumatic rotary motor.

SAVINGS in money and labor, and the improved product which can be effected by proper use of instrumentation have stimulated the use of industrial instruments, control valves, and other automatic control equipment. The horizons of the instrument engineer have broadened and new, improved, and more versatile instruments and control devices are required to satisfy an expanding range of applications. This is particularly apparent in the field of pneumatic control, specifically in the field of pneumatic operators for control service.

PERFORMANCE CHARACTERISTICS

Every pneumatic controller requires a control device to form a control system, and, generally speaking, the performance of the controller can be no better than the performance of the control device. Such control devices take many forms; the most common are the throttling control valve, the damper, and the louver. The control element must be positioned by means of a suitable pneumatic operator with performance characteristics matching those of the controller. These performance characteristics include sensitivity, stability, and accuracy, and also the ability to cope with a wide range of force requirements, stem travels, and speeds of response.

Power is the most important single factor in operator design. To combine a maximum of power and a minimum of cost with precise positioning and accuracy is a challenge. Since power is the product of force times speed, the three factors of force, travel, and speed must be considered concurrently. Because of the wide range of power requirements, there can be no "universal" motor operator. Force requirements vary from a few ounces up to thousands of pounds. Travels vary from a few thousandths of an inch up to 60 inches or more. Rates of stem travel can be anything up to a foot a second or even faster. Therefore, the proper operator can be selected only after due consideration to all these factors.

The spring and diaphragm operator, with its simplicity, ruggedness and low cost, is one of the earliest types of pneumatic power operator. In fact, the spring-and-diaphragm-operated control valve antedates the pilot-operated throttling controller by virtue of its usage with "on-off" controllers. It has, in a measure, been largely responsible for the almost universal acceptance of the pneumatic type of control instrument as one of the simplest and cheapest methods of control.

Advances in control technology and controller application have, however, imposed demands for more powerful and more versatile operators. Long stroke has been provided by new developments in piston and cylinder types of operators. Cylinders also provide a means of obtaining greater thrusts by use of higher air pressures or by pneumatic-hydraulic combinations in which the primary position indication is pneumatic while the piston-operating medium is hydraulic.

FORCE CHARACTERISTICS OF MOTOR OPERATORS

The ideal performance characteristics of a proportional position operator require that it establish and maintain any given position within its operating range within plus or minus one half of one percent or less, regardless of the magnitude of load changes. Although this requirement may not seem rigorous in theory, it is often difficult to accomplish in practice, especially with the simpler types of operators.

The positioning of valves and other control elements involves operating against a number of forces in order to obtain a predetermined and exact position of the control element. These forces may be described as (1) "pressure" load, (2) "weight" load, (3) "inertia" load, (4) "viscous friction" load, and (5) "static friction" load.

A *"pressure" load* exists in all single-seated valves of the globe type and in butterfly valves operating at high pressure-differentials. This force is due to the pressure differential acting against the effective area of the restricting plug or vane. It is usually, but not always, unidirectional —that is, it acts in only one direction. Occasionally, the force reverses its direction at wide openings because the downstream dynamic pressure of the fluid becomes less than the upstream static pressure. The magnitude of the "pressure" load depends on the fluid pressures at the valve and on the effective area of the flow restricting device. Thus,

$$F_v = K_v A(\Delta P), \qquad (1)$$

where F_v = pressure force in lbs., K_v = dimensionless coefficient, A = area of flow-restricting device, and P = pressure differential across flow-restricting device

The "pressure" load, therefore, varies as the area of the valve plug and the magnitude of the pressure differential.

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*Presented by R. B. Werey, Pres., Conoflow Corp., before the Sixth Annual Symposium on "Instrumentation for the Process Industries," Sept. 10-14, 1951, at Houston, Tex.

This brings into focus one of the most serious difficulties in positioning against "pressure" loads, namely, the variations in pressure differential. The pressure differential across a valve is rarely constant inasmuch as it fluctuates with flow. This imposes a fluctuating load on the motor operator.

"Weight" load exists in large valves and dampers where the unbalanced weight of moving parts must be supported by the motor-operator. This force is always unidirectional because it is established by gravitational force. The magnitude of the "weight" force is nearly always constant with time. Therefore,

$$F_w = W, \tag{2}$$

where F_w = weight force in lbs., and W = weight of moving parts supported by the motor.

Obviously, the weight load must include the unbalanced weight of the moving parts of the motor operator.

"Inertia" load is encountered where the mass of moving parts is large and where the required rate of repositioning is high. This force arises from the acceleration and deceleration of the moving parts, according to the simple form of Newton's Law:

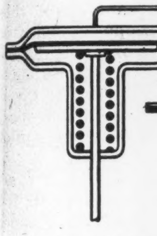

Fig. 1. Spring-diaphragm motor.

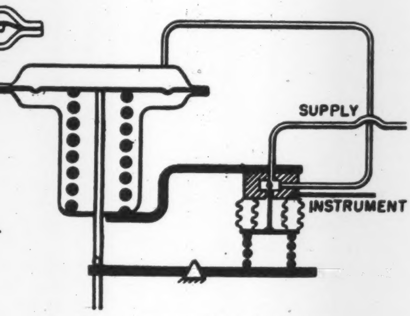

Fig. 2. Diaphragm motor with positioner.

$$F_i = (W/g)a = (W/g)\, d^2x/dt^2, \tag{3}$$

where F_i = inertia force in lbs., g = acceleration due to gravity in ft./sec.^{2}, and a=acceleration in ft./sec.^{2}

"Inertia" load always acts in the direction of acceleration and thus is not unidirectional. "Inertia" force is always large when the weight and acceleration are large, but the reverse is not necessarily true because it is often possible to counterbalance a weight load.

"Viscous friction" load may be caused by fluid damping (as in a dashpot) or by well-lubricated surfaces (as in bearings or packing glands). The dashpot establishes a resisting force proportional to velocity:

$$F_v = b(dx/dt)^n, \tag{4}$$

where F_v = damping force in lbs., b = damping coefficient in lbs. sec.^{n} $ft.^{-n}$, and dx/dt = velocity in ft./sec.

Generally, it is assumed that the resisting force is proportional to the first power of velocity, so that $n = 1$ in equation 4. Viscous damping exists at well-lubricated surfaces moving over one another. For example, in the packing gland of a valve stem, the viscous damping force may amount to several hundred pounds for a velocity of one foot per second, whereas the static friction may be negligible. Viscous-friction load is a variable depending on the area of surfaces, their smoothness, and the size of packing glands. Viscous-friction loads always oppose the velocity and thus may act in either direction.

"Static friction" load exists at contact surfaces up to the point of relative motion between the two surfaces, and is proportional to the normal force between the surfaces. The "static friction" force is given by:

$$F_s = uN, \tag{5}$$

where F_s = friction force in lbs., u = coefficient of static friction, and N = normal force at surfaces in lbs.

Static friction force always opposes impending motion of the two surfaces and therefore acts in either direction on a motor operator stem.

All five types of forces co-exist in any motor operator application, although certain of them may not be of sufficient magnitude to be of any consequence. A one-inch single-seated control valve causes a "pressure" load on a motor operator by virtue of the pressure differential across the valve plug. The "weight" load is negligible because the weight of moving parts is small. A "viscous friction" load exists at the packing gland and, with a tight but well-lubricated packing, this may be high. The "static friction" load at the packing gland may be large or small depending on the type of packing and the amount of lubrication.

A large butterfly valve has a rotary stem motion and the various forces are designated as "torques." The "pressure" torque may be relatively large because of the action of the dynamic pressure against the vane (aerodynamic effect). The "weight" torque is small because the vane is nearly balanced. The "inertia" torque can be large if the rate of repositioning is high. The "viscous friction" is moderately small when the packing on the vane shaft is not too tight. The "static friction" may be appreciable because the full weight of the vane rests on the bearings.

These examples illustrate that the five characteristic forces exist in varying degree in every application.

SPRING-DIAPHRAGM AND SPRING-PISTON MOTORS

The spring and diaphragm motor is used widely for positioning valves, dampers, louvers, and other control devices. As shown in Fig. 1, it consists of a diaphragm clamped around the periphery in a suitable housing, with air pressure applied to one side. A spring opposes the motion of the diaphragm and is designed with a preload; that is, the spring exerts an upward force even when the displacement is zero. The principle of operation is the same if the diaphragm is replaced by a piston.

The basic calibration of the spring-diaphragm or spring-piston motor is given by:

$$P_R A = KS, \tag{6}$$

where P_R = pressure range in psi., A = effective area of diaphragm or piston in sq. in., K = modulus of spring in lbs. per in., and S = stroke of motor stem in inches.

When operating a spring and diaphragm motor with either a "pressure" load or a "weight" load, the maximum downward thrust must be limited to the preload of the spring because otherwise full up-stroke could not be attained. Likewise, the maximum upward thrust is limited to the over-range pressure because otherwise full down-stroke could not be obtained. The motor operating range is usually adjusted so that the spring preload is equal to the over-range load. Thus the motor range for a 16-psi. air supply may be 1 to 15 psi., 2 to 14 psi., 3 to 13 psi., and so on. Then the maximum pressure load and maximum weight load, neglecting the weight of moving parts, is given by:

$$F_p = F_w \leqq P_0 A, \tag{7}$$

where P_0 = initial load in psig.

The maximum pressure output of most industrial pneumatic controllers (P_s) is about 16 psig., although there is a trend to a 20-psig. maximum operating pressure.

The diaphragm motor is thus able to handle only moderate "pressure" and "weight" loads. Diaphragm areas cannot be increased much beyond 200 sq. in. without the motor becoming unwieldy in physical size. Therefore, the spring and diaphragm motor is limited to "pressure" and "weight" loads less than 300-400 lbs., even in large sizes.

The most serious difficulty encountered in spring and diaphragm motors arises from changing (unsteady) "pressure" loads. If the accuracy of positioning is to be within plus or minus one-half of one precent of full stroke, then any given value of F_p is limited by the relation:

$$\triangle F_P \leqq P_R A/200. \tag{8}$$

For a motor with a diaphragm area of 200 sq. in. and a 12-psi. operating range, the "pressure" load should not change more than about 12 lbs. from a given value.

When operating with an "inertia" load, the diaphragm motor becomes a mechanical oscillating system consisting of a spring and a mass with small damping. The period of oscillation of a diaphragm motor with a 400-lb. weight of moving parts and a 3-inch stroke is about 0.3 second. It is possible that resonance difficulties may be encountered in large spring-diaphragm motors and spring-piston motors with large inertia loads.

For operation with "viscous-friction" load, it is necessary to analyze the equation of motion:

$$(W/g)\ (d^2x/dt^2) + b(dx/dt) + Kx = 0, \tag{9}$$

where x = stem position in ft., b = viscous friction coefficient in lbs. sec./ft., and k = spring modulus in lbs. per ft. This is the common equation of damped vibration; it possesses three typical transient solutions: (1) Oscillatory when $gb^2 < 4KW$, (2) critically damped when $gb^2 = 4KW$, and (3) overdamped when $gb^2 > 4KW$. The maximum value of the viscous-friction load coefficient (b) can be determined from limitations given by the desired speed of response of the operator.

Under most operating conditions the motor response is approximately critically damped or slightly oscillatory. The lag of the motor response in seconds is given approximately by:

$$T = 2W/gb. \tag{10}$$

The maximum viscous friction load is therefore given by:

$$b \leqq 2P_0A/gT, \tag{11}$$

where T is the largest allowable lag in seconds. Thus, for a motor with an "inertia" load of 400 lbs. and a lag of 10 seconds, the viscous friction load should be less than about 2.5 lbs. per ft.-per-sec. velocity.

When operating with a "static-friction" load, it is necessary that the motor stem move with a change in applied pressure. As it is desired that the motor respond to an applied pressure change of at least plus or minus one half of one percent, then

$$F_s \leqq P_RA/200. \tag{12}$$

The maximum friction load is given by the same relation as that for maximum change in "pressure" load (equation 8).

This analysis shows that the positioning ability of a spring-diaphragm operator is limited by the loads against which it may operate. It is particularly poor in operation under changing "pressure" loads and under "static friction" loads. In addition, it is generally limited to travels of less than three inches because of difficulties in the design and manufacture of a diaphragm for long travel.

The use of a positioning relay improves the usefulness of any spring-diaphragm motor. A positioner (Fig. 2) is a pneumatic relay which places any air pressure on a pneumatic motor (up to the limit of the supply pressure) in order to obtain a motor stem position corresponding to the output pressure of the controller. It is a pneumatic servo device. Although the positioner does not increase the allowable "pressure" or "weight" load when used with a spring and diaphragm motor, it is effective against changing "pressure" loads because it can automatically counteract changing loads and maintain a fixed motor position. A positioner greatly improves operation against viscous friction and static friction loads because of the amplifying actions of the positioner pilot. This amplification action can be as high as 50 or 75 to 1.

SPRINGLESS MOTORS

For operation with large "pressure" or "inertia" loads, the springless motor has all the advantages of the spring motor with positioning relay and, in addition, can handle much larger weight and pressure forces. The springless diaphragm motor consists of a diaphragm rigidly clamped between two pressure housings, a positioning relay controlling the pressure on one side of the diaphragm, and a pressure regulator maintaining a fixed but adjustable pressure on the other side. The principle is illustrated in Fig. 3. A springless piston motor is shown in Fig. 3,B.

In a springless motor, the "pressure" or "weight" load of a unidirectional type is limited only by the maximum pressure that can be applied to the diaphragm or piston. For example, suppose the downward force on the diaphragm were equivalent to one half the maximum pressure output of the positioner. The underside loading can then be set to one half the maximum pressure output of the positioner. For maximum upward force, the underside loading is set to a small minimum, such as 1 psi. The maximum "pressure" or "weight" load (acting downward) is then,

$$F_p = F_w \leqq P_sA/2, \tag{13}$$

where P_s = supply pressure in psi.

For changing "pressure" loads, the springless motor has a further advantage. The "pressure" load may drop nearly to zero, or may rise almost to the maximum (P_sA) and the positioner is still able to control stem position adequately. Therefore,

$$\Delta F_p \leqq P_sA/2. \tag{14}$$

When used with viscous friction loads and static friction loads, the springless motor is equal to or better than the spring and diaphragm motor with positioner.

Although the springless pneumatic motor can handle large "weight" loads, difficulties may be encountered with "inertia" load. For example, a springless motor with a diaphragm area of 100 sq. in. and a 30-psi. air supply can theoretically handle 1500 lbs. of "weight" load. But if this were tried, the "inertia" of the load might cause the motor operator to oscillate if rates of repositioning were high and if viscous damping were small. An analysis of this situation is beyond the scope of this article, but suffice to say that springless motors of either the diaphragm or piston type are limited to "inertia" loads less than the corresponding theoretical "weight" load. No general rule can be given as to maximum inertia load inasmuch as the dynamic operation depends largely on the design of the positioner pilot and the magnitude of viscous and static friction.

Fig. 4 shows a springless piston operator. Piston operators permit the use of operating air pressures up to 100 psi., whereas the maximum pressure in diaphragm types is limited to approximately 50 psi. by virtue of diaphragm-strength limitations.

Conventional cylinders, such as used in the machine-tool industry, are unsatisfactory for use in proportional positioning operators, primarily because of the excessive friction associated with leather-cup-type packings. Sealing is accomplished by means of special graphite-impregnated "O" rings sliding on a highly polished cylinder wall. Such devices provide larger forces and longer travels in a more compact form than the equivalent diaphragm operator; this lends itself to simpler and more versatile mounting arrangements.

PNEUMATIC ROTARY MOTORS

The use of a positioning device involving a combination of rotary pneumatic driving motor, gear train, and positioning relay is a relatively new commercial development in the field of pneumatic operators. Such a device is illustrated in Fig. 5. A rotary pneumatic motor drives a threaded screw stem through a gear train and provides the linear motion necessary for operating large valves and dampers. The positioning relay determines stem position by supplying air at 80 to 100 psi. to either the forward or reverse parts of the driving motor.

When operating under "pressure" or "weight" loads, the maximum load for this operator is limited only by the available horsepower of the driving motor and the structural

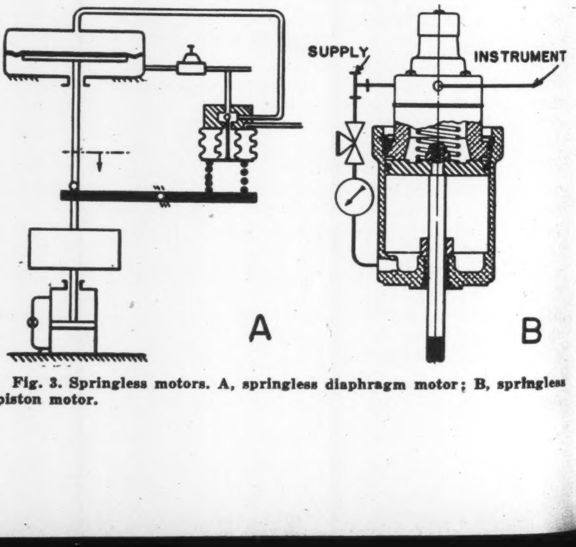

Fig. 3. Springless motors. A, springless diaphragm motor; B, springless piston motor.

strength of the gear train. Thus, the maximum operating load is given by,

$$F_P = F_w \leqq (HP) \times 550 \times 12 \times t \times E/S, \qquad (15)$$

where HP = horsepower rating of motor, t = time for full stroke in seconds, S = stroke of motor stem in inches, and E = gear-train efficiency (approx. 0.4). The maximum load that can be handled at any speed is, of course, limited by the stalling torque of the motor.

When operating with an "inertia" load this system is unusually stable because of the large amount of viscous damping in the gear train, the positive self-locking screw stem and the fact that inertia in the operator itself is small.

When operating with a "viscous friction" load the maximum load is limited by the desired speed of travel. Thus,

$$b \leqq (HP) \times 550 \times 144 \times E \times T^2/S. \qquad (16)$$

When operating with a "static friction" load the maximum load is limited only by the stalling torque of the motor.

The rotary pneumatic motor has advantages other than its ability to handle large load. For example, with its self-locking gear train, the motor remains in its last position in event of air failure. This feature is often desirable in continuous process industries. Another feature is the ability to provide almost unlimited linear stem travel, either short or long, without any sacrifice in sensitivity or stability, and without materially increasing physical size.

SUMMARY

Proper design of a pneumatic operator for proportional position control requires careful consideration of the force loading imposed by the control element. The power characteristics of force, time, and speed must be adequate to combat the "pressure," "weight," "inertia," viscous friction, and static friction forces in order that the motor operator will possess good performance as to sensitivity, stability, and accuracy.

The ordinary spring-diaphragm pneumatic operator is extremely limited when employed under conditions of changing "pressure" load or static friction load. Operation of this type of motor can be improved by the use of a positioning relay.

The springless motor of the diaphragm or piston type is an important improvement over spring-diaphragm motors in that it provides for greater "pressure" loads, longer travels, and improved stability and sensitivity.

The rotary pneumatic motor approaches the ideal in handling heavy loads of all kinds. With its self-locking gear train it becomes an extremely stable operator—unaffected by sudden variations in stem loads and line pressures. It can handle long stem travels as easily as short travels without appreciable increase in physical size.

DISCUSSION

Dr. J. D. Lindsay: What about the air consumption of the gear-driven rotary-type pneumatic positioning mechanism?

R. B. Werey: Air consumption on this unit is a function of the nature of the control job—it depends on the frequency and magnitude of the loading changes. On the average heavy-duty job, the driving motor will be operating only a small percentage of the time, possibly somewhere between 3 to 20 percent of the time; the air consumption will, of course, be reduced proportionately. We normally calculate the air consumption for the smaller units (capable of handling thrusts up to 10,000 lbs.) at anywheres from 3 to 8 CFM.

G. Grespp: Is there any advantage to the use of a so-called reversing relay instead of a cushion loading relay in the operation of these pistons?

Werey: The value of a reversing relay instead of a simple cushion loading relay with this type of piston is questionable except when the device is used to position purely frictional loads of considerable magnitude. When one examines critically the nature of the average control job, he sees that only a small percentage of them involve purely frictional loads. For the most part, they are unidirectional, such as encountered in the positioning of single-seated globe valves, Saunders patent diaphragm valves, and even double-ported valves. For such applications, the cushion loading relay makes a more stable device without any sacrifice in power or speed.

L. W. Parten: Are there any assemblies of valves which can be classified as one hundred percent friction loads?

Werey: Yes, one of the best examples is the so-called paper stock valve, such as made by the Crane Co. and others. These valves have extraordinarily large glands and are of the gate-valve type of construction.

Scanner: Have you any figures comparing the time to stroke a piston as compared to diaphragm motors?

Werey: Yes, there are several factors which make the piston-type operator much faster than the average diaphragm motor. For one thing, pistons can use higher air pressures and, therefore, reduce the net volume requirements

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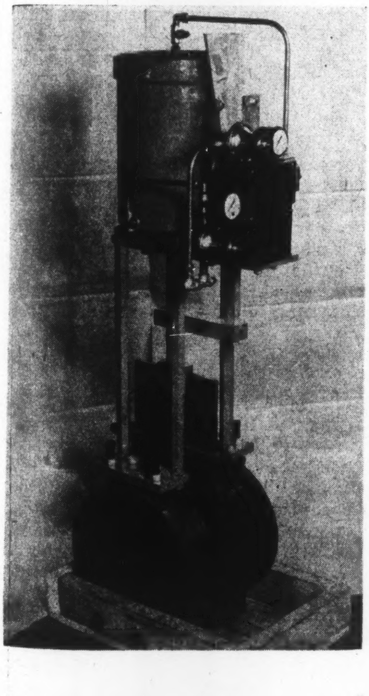


Fig. 4. A springless piston operator for throttling control service on paper stock valve. Stem travel is up to ten inches.

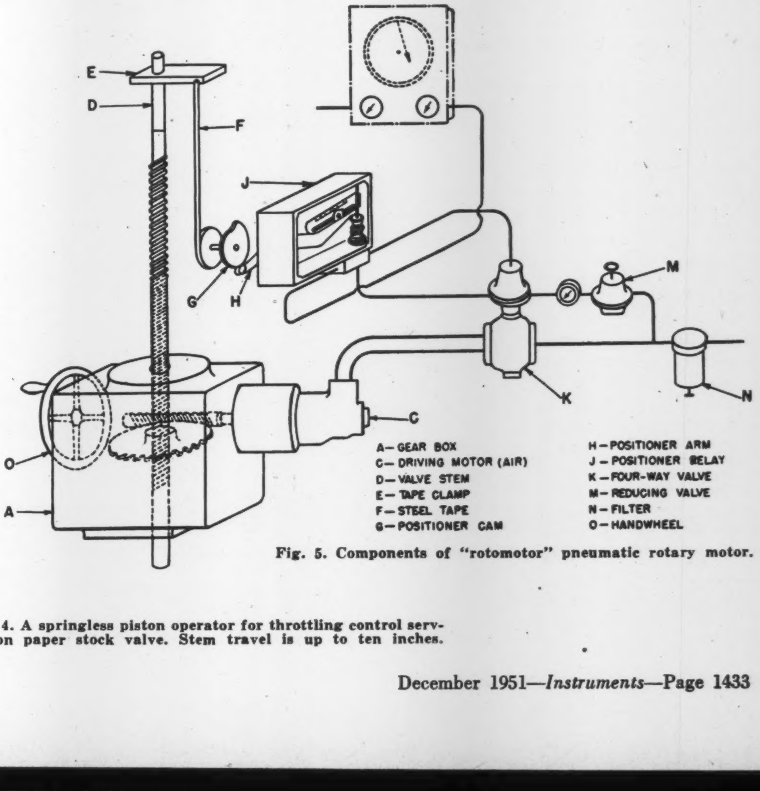
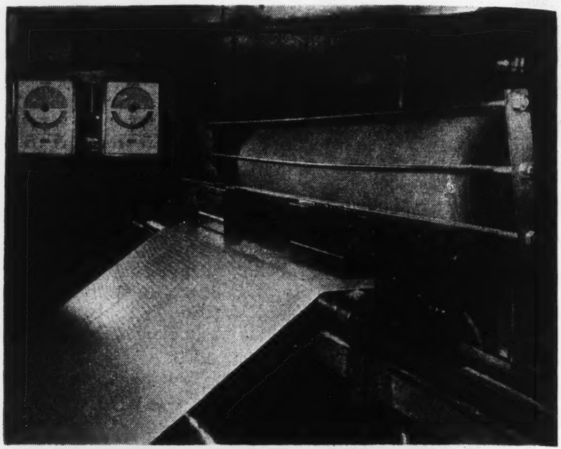


Fig. 5. Components of "rotomotor" pneumatic rotary motor.

Application *of* Dielectric Measurement *to* Continuous Processes

By **WILFRED H. HOWE**, Chief Engineer,
The Foxboro Company, Foxboro, Mass.

Measurements on continuous industrial processes are becoming more important daily. Capacitance-measurement techniques are already in use for continuous measurement of weight and moisture of sheet materials. This article covers principles and applications of the technique, including primary elements and electric circuits, for capacity measurement of solids, liquids, and gases. The state of the art is presented.



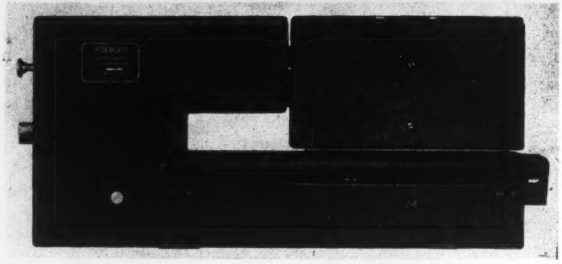


Fig. 1. Capacity-weighing installation.
Fig. 2. (below) Weighing capacitor.

MEASUREMENT of the characteristics of a material by measurement of its dielectric properties is a well-recognized technique. In line with the modern trend toward continuous measurements on actual product, the application of dielectric measurement to continuous processing has received considerable attention. This article discusses industrial applications of dielectric measurement as applied to measurement of continuously moving material.

PRINCIPLES

The dielectric properties of matter are fundamental; dielectric measurements can yield basic data on the material measured. In practice, a more or less arbitrary calibration generally is used, based either on measurements of prepared samples of known composition, or from analysis of product which gives a particular dielectric measurement. Either true dielectric constant may be the basis of measurement, or dielectric losses may be a factor. When properly engineered, the consistency and reliability of dielectric measurements are excellent.

Measurements by means of dielectric properties have a number of advantages. They are definite and unambiguous. They are unaffected by traces of contaminating material, except for the addition of polar molecules having high effective dielectric constant. They are applicable to material in both the solid and liquid states. The primary measuring elements are simple capacitors, usually consisting either of a pair of parallel flat plates or of a pair of concentric cylinders. In the conventional measuring circuit, one of these plates is at ground potential; therefore only one insulated plate is required. Measuring elements for flowing fluids can be designed to withstand high pressures and to resist corrosive fluids. Concentric cylindrical capacitors are relatively independent of temperature variation. The measurement is completely electrical, in contrast with mechanical or optical systems in which the accuracy and stability of a motion-to-electrical converter, photocell, thermopile, or bolometer are often limiting factors. As the dielectric properties of many materials vary with temperature, it may be necessary either to maintain the measured material at a constant temperature, to measure the temperature of the material and then correct for temperature variations, or to use a differential system in which a comparison sample is maintained at the working temperature.

Apparatus for measurements based on dielectric properties of materials consists of two units—(1) the structure which converts the change of dielectric properties of the measured material into corresponding variations in an electric circuit element and (2) the electrical system by which variations in the output of the primary element are converted into indications, records, or controlling signals. Several primary elements and circuits are described in this article.

MEASUREMENTS OF DIELECTRIC PROPERTIES OF SOLIDS

One of the oldest industrial applications of dielectric measurement to continuous process operation is the dielectric weighing of continuous web or sheet material. A system was put into commercial operation in 1926 for the measurement of weight per unit area of automobile tire fabric. The process is one in which tire cord in the form of a web is fed to "coating" calendars, which apply layers of rubber to the web of cords to produce a "ply" for tire manufacture. It is important to have a uniform weight of rubber in each ply. Measurement by "dielectric weight" has proved satisfactory for this application. It has been

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generally adopted by the tire industry and has been applied to a variety of other dry (effectively water-free) sheet materials.

Fig. 1 shows a conventional tire-fabric installation. In this system, the material is passed between a pair of 2 x 11 in. plates which are supported at a constant spacing of 0.150 in. The capacity of the flat-plate capacitor is an indication of the "dielectric weight" of the material between the capacitor plates. "Dielectric weight" and physical weight have been found to correlate with a high degree of accuracy.

Fig. 2 shows a weighing capacitor of current design. The yoke and plates are of invar, and the supporting insulators are of fused quartz to minimize temperature errors. The upper plate of the capacitor is hinged to allow irregularities in the web to pass. Considerable care in design and construction of this unit is required because any change in the spacing between the plates produces an apparent change in weight equivalent to about one and one-third times the change of spacing. The capacitor is mounted on slides so that it can be slid over a sheet or withdrawn completely for "zeroing" the system with air dielectric.

A capacity measurement can be considered as a measurement of two capacitors in series. One is the equivalent capacitor corresponding to the dielectric material being measured; the other is an air capacitor comprising the air space between the plates and dielectric material. Total capacity is then found from the equation:

$$1/C_T = 1/C_D + 1/C_A,$$

where C_T is the total capacity of the capacitor, C_D is the capacity of the capacitor corresponding to the dielectric material between the plates, and C_A is the capacity of a capacitor corresponding to the air between the plates.

An air-filled capacitor with capacity C_D would have an effective plate spacing equal to the thickness of the dielectric material divided by its dielectric constant. Therefore, the total capacity of the system (C_T) is the same as if the same plates had only air between them but were moved closer together by the thickness of the dielectric material minus this thickness divided by the dielectric constant. The more material there is between the plates, the closer the equivalent plate spacing and the larger the capacity change resulting for a unit change of material thickness or weight. Fig. 3 shows capacity versus material thickness for materials with dielectric constants of 3, 3.5, and 4.

Fig. 3 illustrates the effect of change of dielectric constant. Note that with a 0.060-in. thickness of material, an increase of dielectric constant from 3.0 to 4.0, or 33 percent, produces an increase of capacity of 3 uuf. The same change of capacity is produced by an increase of material thickness from 0.060 to 0.066 in., or 10 percent, at constant dielectric constant of 3.0. In practice it has been found that the changes in dielectric constant which occur under working conditions are small enough so that no correction is required despite the fact that the consistency of measurement is within 1 percent of the material weight. This holds as long as the moisture content of the material is low. For tire-fabric calendering, the moisture content of cord material must be maintained below 3 percent.

In practice, calibration is established running the material to produce a constant measurement and then either checking the average weight of the run of material or marking spot samples and check weighing these later. The established calibration is set in manually by the operator for the material being run. The instrument operates as a deviation indicator and recorder to show the amount by which the material weight runs above or below the desired setting.

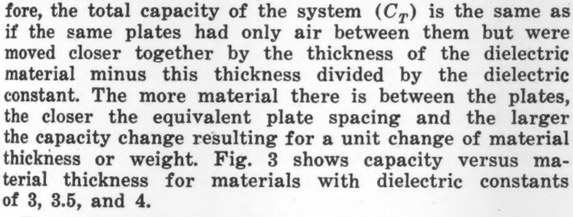


Fig. 3. Curves of capacity versus material thickness for materials of different dielectric constant.

MEASUREMENT OF MOISTURE IN SOLIDS

The above procedure applies to measurements of traveling web materials which contain negligible amounts of water or other material with polar molecules of high effective dielectric constant. A modified procedure is employed for measuring water content of traveling web material. The capacity variations due to the presence of water are large in proportion to the capacity changes from variation of the background material of low dielectric constant.

These measurements are used for cellulose material such as paper and cloth. In these materials, water is held in the microcapillaries of the cellulose. This distribution of water introduces a "form factor" which causes a larger increase in capacity per unit quantity of water than would occur if the same quantity of water were introduced as spherical droplets. The capacity change for each percent water content varies, depending on the microstructure of the material. Apparently, this is a mechanical effect, depending on the diameter and length of the capillaries. Changes in dyes or filler material apparently have a negligible effect, although these changes may produce an appreciable change in conductivity as measured by contacting devices. This measurement has been widely applied to measurement of moisture in textiles where the running weight of the material remains relatively constant during a run. As a 1 percent change in moisture content produces a capacity change equivalent to from 4 to 8 percent change of weight of the dry material, normal variations in weight of the material have a relatively minor effect.

From the practical mechanical standpoint, there are objections to passing the measured material between the plates of a capacitor. Several attempts have been made to measure the moisture content of material by the spray field of a capacitor consisting of parallel conductors located adjacent to each other on the same side of the sheet. Siemens and Halske in Germany marketed such a unit years ago. We do not have authentic information as to its performance. A similar device for measurement of moisture content of wood has been developed, which has received considerable acceptance. In this case, the problem is simplified by the fact that the thicknesses of the material measured are large compared to the penetration of the spray field. Attempts are continuing to improve this procedure. There is a demand for a device of this kind; a solution should be forthcoming.

Moisture content has been measured by the use of a capacitor with a hygroscopic dielectric maintained in continuous contact with the moving sheet being measured. In this way, moisture equilibrium between the traveling web and the hygroscopic material in the capacitor was maintained. Thus the moisture content of the measuring capacitor (and hence its capacity) gave the moisture content of the sheet material. This sort of device has been used widely in paper manufacture; under favorable circumstances, it has given satisfactory results. The requirement of maintaining hygroscopic equilibrium between the measured sheet and the hygroscopic capacitor has caused limitations on this method.

A number of moisture measurements of bulk or granular material have been made. It is fairly common to spot check moisture content of grain by dielectric means, though this is commonly not a continuous measurement. Experimental units are in service where grain meals are passed continuously through a tube with capacitor plates on opposite sides of the tube. A feeder provides a constant flow of material so that a satisfactory measurement of moisture content is obtained.

Moisture content of granular material has been accomplished by distributing the material in a constant layer on a turntable. The turntable carries the material under a fixed capacitor plate to determine its moisture content. In this method, the problem is almost entirely mechanical; the accuracy of the measurement is limited by the uniformity of the layer which can be produced.

MEASUREMENTS OF DIELECTRIC PROPERTIES OF LIQUIDS

Industrial measurement of the dielectric constant of continuous flowing liquids is a comparatively recent development, although electric conductivity measurement is a well-established technique. Although the results obtained appear promising, there is still a lot of work to be done; available data on results obtained in industrial practice are limited. The principles are the same as for solids.

The problem is simplified by the fact that it is easy to completely fill the measuring cell with the measured material. In a mixture, if the materials are mutually soluble and have dielectric constants of the same order of magnitude, it appears that the effective dielectric constant is the same as if the material were in separated layers, with total capacity computed by the series-capacity formula. For small quantities of material of high dielectric constant in emulsion, extension of the Clerk Maxwell field equations indicates that for spherical droplets the increase in capacity is roughly three times as much for the same quantity of material in a single uniform layer. This applies when the size of the droplets is small compared to their spacing. The same principle appears to hold for small quantities of high-dielectric-constant material in solution. Both theory and experimental results demonstrate that capacity variations are consistent and linear with composition. Since calibration usually is established by measurement of samples of predetermined composition, practical calibration is simple and straightforward.

Fig. 4 shows a cell constructed of 316 stainless steel with Teflon insulation. This unit can be inserted in a main flow or by-pass line with the flow itself providing the necessary circulation. Fig. 5 shows a cross section of this cell. Similar cells have been constructed where the outer cylinder is solid and forms a container through which a small sample flow is directed.

The dielectric constant of most liquid dielectrics changes with temperature. For example, the dielectric constant of kerosene varies 0.04 percent per deg. F. For accurate measurement on most liquids, temperature control or correction is required. A corrector may be made in the form of a mechanical thermal system with the output linked directly to a mechanically variable capacitor connected in parallel with the measuring capacitor.

By altering the electrical circuit to provide differential capacity measurement, it is possible to use a compensator in the form of a duplicate measuring capacitor permanently filled with an average sample of the liquid. With this reference capacitor (or cell) immersed in the stream to maintain it as nearly as possible at the temperature of the measured fluid, automatic correction is obtained. Fig. 6 indicates diagrammatically a setup of this type. There is obviously an appreciable lag in temperature response of a system of this type. The average sample of material should be stable and representative of the material measured. Where these requirements can be met, accurate compensation is obtained by this method. A combination of a reference capacitor and temperature control has been used for added precision.

Capacity measurement of materials having high dielectric losses presents greater problems. Laboratory measurements of certain samples have been made. However, the problems of separating true dielectric loss from actual conductivity and of measuring dielectric constant in the presence of these losses have limited the application of this technique. In many situations, measurements of fluid conductivity are adequate and simpler.

MEASUREMENT OF MOISTURE

Measurements of moisture content of liquid dielectrics have proved successful where circumstances are favorable. As would be expected, changes in dielectric constant of the water have relatively little effect; it makes little difference whether the water is a high-grade distilled water with a dielectric constant of 80 or whether it is a salt water with sufficient conductivity to have an infinite dielectric constant at the frequencies used. For small amounts of water as an emulsion, the capacity is independent of the size of the droplets. We can assume that the effect of water in solution or emulsion is roughly three times as much as if the same quantity were collected in a uniform flat layer. Taking the equivalent capacities and adding them in series in much the same manner as was done for the measurement of weights of traveling solid web, the percent increase in capacity works out to be almost exactly three times the percent water content. Thus with 98 percent of liquid of dielectric constant 3.0 and 2 percent of water with dielectric constant 80, the dielectric constant of the solution or suspension will be roughly 3.2 and not 4.5 or more.

In the measurement of small amounts of water, compensation must be provided for variation of dielectric constant of the solvent or suspending material caused by change of composition or temperature. The problem is much the same as for measurement of liquid mixtures. The degree of accuracy of compensation required is established by the sensitivity to moisture content desired. Experimental procedures for total moisture-content variation of the order of two hundred parts per million with corresponding capacity changes have been undertaken. The difficulties of correction and compensation for background effects as well as the problems of electrical and mechanical stabilization are obvious.

DIELECTRIC MEASUREMENTS OF GASES

Laboratory measurements of the dielectric constants of gases are available. At atmospheric pressure these values are all close to 1.0. Taking the dielectric constant of vacuum as 1.0, the Smithsonian Physical Tables give the dielectric constant of air as 1.000588, methane as 1.000948, and hydrogen as 1.000264. Some gases, such as hydrochloric acid gas at 1.00258 and sulphur dioxide at 1.00993, are

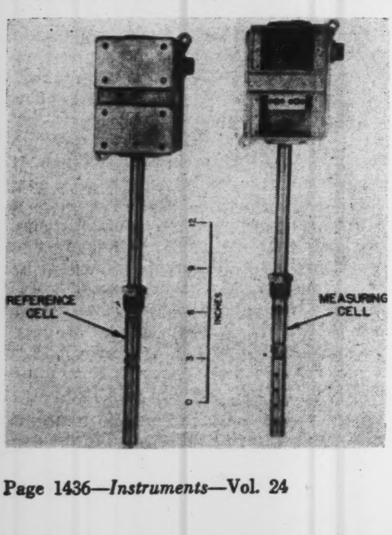


Fig. 4. Cells for measuring dielectric properties of liquids.

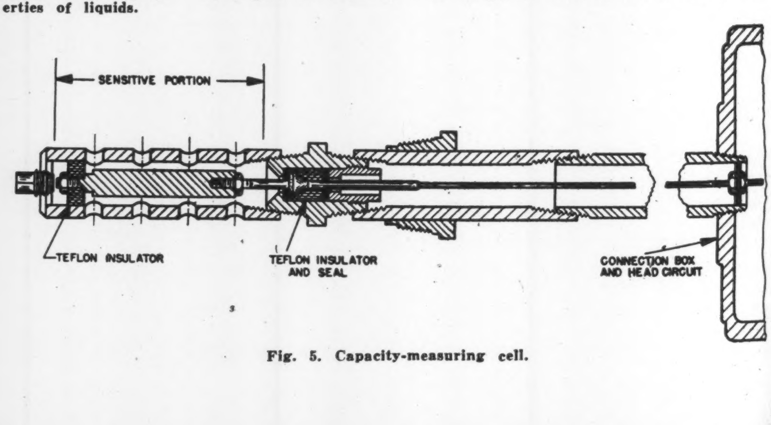


Fig. 5. Capacity-measuring cell.

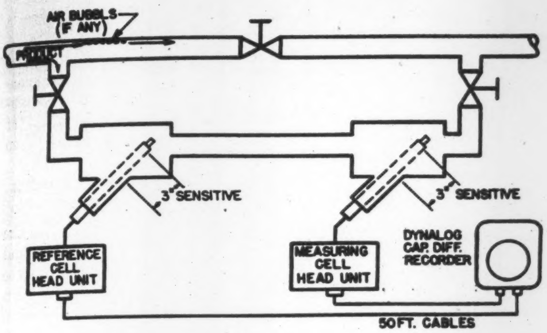


Fig. 6. Temperature compensation using capacity-differential method.

higher but still produce a capacity change of less than 1 percent for 100 percent change of composition. While it would appear that measurements at moderate or high pressures might be made with commercially available equipment, so far as is known, there is no industrial application in operation. The probability of improved stability and sensitivity in electric measuring systems gives promise that this type of measurement may be accomplished in the future. However, for the present, industrial measurement of dielectric properties of continuous flowing gas streams remains an interesting possibility.

MEASURING CIRCUITS

There are a large number of electric measuring circuits for determining the dielectric properties of materials. The particular choice depends not only on the measurement required, but also on the individual preference of the circuit designer.

For values of capacitance and capacitance variation usually encountered in continuous industrial dielectric measurement, radio-frequency measurement with the use of resonant circuits has considerable advantage. A high frequency reduces the impedance of the capacitance to a convenient value, as compared with possible leakage-resistance values. For example, a 100-uuf. capacitor has a capacitive impedance of 25 megohms at 60 cycles, 1.6 megohms at 1,000 cycles, and 800 ohms at 2 megacycles. It is apparent that leakage resistances in the order of 10 megohms would have overwhelming effects at 60 cycles, serious effects at 1,000 cycles, but be almost negligible at 2 megacycles. In bridge circuits, stray capacities and inductances present problems at radio freqeuncies. Even more important is the fact that resistive balance as well as reactive balance is required on an a-c. bridge. If the dielectric losses vary appreciably, the minimum absolute value of the "null balance" signal arrived at by capacity balance alone may be large because of residual quadrature component. This requires either a manually or automatically operated secondary balance or specialized phase-sensing and limiting apparatus.

Resonant circuits are simple, consisting simply of the inductive winding and perhaps a trimmer capacitor in addition to the measuring capacitor. They can be designed to give large reaction to small changes in capacity, with single-valued response to variations of the dielectric properties.

Resonant circuits for measurement of capacity variation are almost as old as commercial vacuum tubes. Fig. 7 shows the circuit from the Dowling patent, issued in 1922. This patent covered a variety of measurements of physical properties by means of the resultant variation in capacity. There are almost as many variations of this circuit as there are circuit designers.

The measured capacity may directly affect the oscillator performance, or a fixed-frequency oscillator may drive a secondary resonant circuit containing the measuring capacitor. Although these circuits tend to be subject to variations of supply voltage, tube characteristics, and component temperature, they are relatively simple and, where high accuracy and stability are not requirements, they have proved adequate.

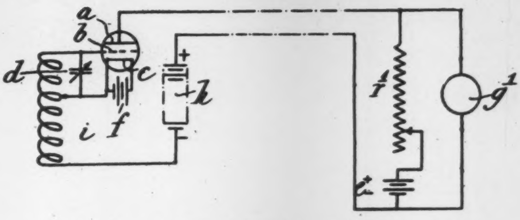


Fig. 7. Reproduction of circuit from Dowling patent.

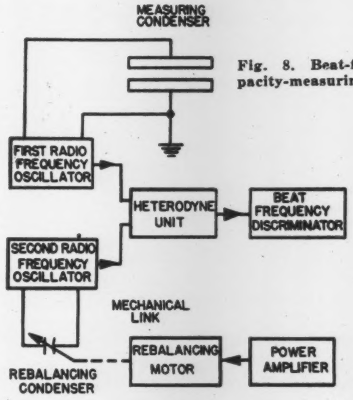


Fig. 8. Beat-frequency capacity-measuring system.

Beat-frequency Systems. In an effort to eliminate the shortcomings of these single-resonant circuits, beat-frequency measuring systems have been employed to a considerable extent. Fig. 8 shows a block diagram of a typical circuit. In these systems, the measuring capacitor forms all or part of the tuning capacity of one of two radio-frequency oscillators. The tuning of the second of the two oscillators is accomplished either by a fixed capacitor or by a variable capacitor manually or automatically adjusted to restore balance. With the exception of the measuring and rebalancing capacitors, the two oscillators are nearly identical; variations in line voltage, tube characteristic, and temperature thus affect both in an identical manner and hence do not affect the resulting beat frequency.

The frequency of the first oscillator varies with variations of the measuring capacitor; the difference between the frequencies of the two oscillators is detected in the form of a beat frequency. This beat frequency may be measured by a suitable frequency meter, or the rebalancing capacitor may be manipulated manually or automatically to maintain both oscillators at the same frequency (zero beat) or at a constant difference of frequency (constant beat frequency). The latter rebalancing procedure has the advantage of being a fully balanced system with the direction of deviation of the frequency of the first oscillator readily distinguished as increase or decrease in the beat frequency. This contrasts with the zero beat procedure where the direction of the deviation is not readily apparent.

When oscillator frequencies in the megacycle range are used, it is possible to balance to within 1 cycle per second. By selection of the operating frequencies or by padding the measuring capacitor, almost any ratio of change of capacity to change of beat frequency can be obtained. Variation between the characteristics of the oscillator tubes may have some effect on the measurement; care in design of the oscillator circuits will minimize this. A number of satisfactory beat-frequency systems have been used with excellent results.

"CAPACITY DYNALOG"

The circuit used in the "Foxboro Capacity Dynalog" retains the advantages of the duplicate resonant circuits; it incorporates a simple balancing mechanism; the effects of

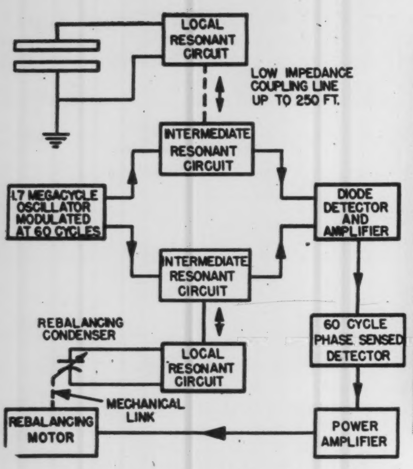

LOCAL RESONANT CIRCUIT
LOW IMPEDANCE COUPLING LINE UP TO 250 FT.
INTERMEDIATE RESONANT CIRCUIT
1.7 MEGACYCLE OSCILLATOR MODULATED AT 60 CYCLES
DIODE DETECTOR AND AMPLIFIER
INTERMEDIATE RESONANT CIRCUIT
REBALANCING CONDENSER
LOCAL RESONANT CIRCUIT
60 CYCLE PHASE SENSED DETECTOR
MECHANICAL LINK
REBALANCING MOTOR
POWER AMPLIFIER

Fig. 9. Block diagram of "Capacity Dynalog."

Fig. 10. "Capacity Dynalog" recorder.

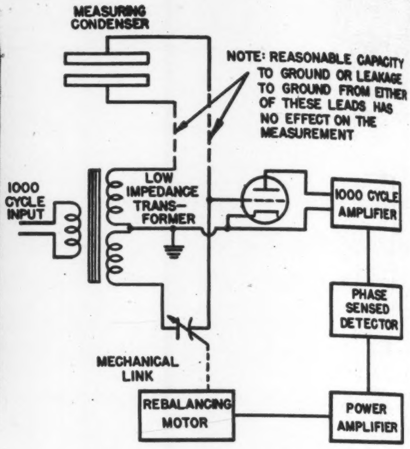

MEASURING CONDENSER
NOTE: REASONABLE CAPACITY TO GROUND OR LEAKAGE TO GROUND FROM EITHER OF THESE LEADS HAS NO EFFECT ON THE MEASUREMENT
1000 CYCLE INPUT
LOW IMPEDANCE TRANS-FORMER
1000 CYCLE AMPLIFIER
PHASE SENSED DETECTOR
MECHANICAL LINK
REBALANCING MOTOR
POWER AMPLIFIER

Fig. 11. Diagram of bridge circuit.

dielectric losses are minimized. This instrument in standard form is a commercial product with field experience.

Fig. 9 shows a block diagram of the circuit. A single common oscillator is employed, operating at 1.7 megacycles and modulated at 60 cycles. Twin resonant systems are energized through coupling capacitors from this oscillator. As both resonant systems have similar characteristics, small variations in the oscillator frequency react equally on both systems and balance out. Each of these resonant systems includes two tuned circuits. The measuring capacitor is in one of these. A low-potential low-impedance concentric cable couples this first circuit to the second circuit, located in the instrument proper. The impedance of the first circuit causes the voltage of the second circuit to vary in a linear manner with variation of the capacity of the measuring capacitor. A characteristic of this coupled resonant system is that for a chosen null point on the linear response characteristic, changes in dielectric losses (within reasonable limits) have no effect on the potential across the system; whereas for all other points on the characteristic curve, the effect is proportional to variation of losses and the deviation from the null point. By choice of the relation of the working range of capacity measured with respect to this null, effects of dielectric-loss variation are minimized.

The potentials across the secondary resonant systems are applied to a twin-diode detector, which provides two 60-cycle signals—each proportional to the capacity in its particular system. These two 60-cycle signals are opposed, and the difference is applied through an amplifier and phase discriminator to a balancing motor which operates the balancing capacitor to make its capacity equal the capacity of the measuring capacitor, at which point the two 60-cycle signals are equal. The recording pen is coupled to the balancing capacitor; its reading is a measure of the capacity of the measuring capacitor and thereby the characteristic of the material being measured.

With some modifications this circuit can be set up for capacity-difference measurement. The modification consists basically of arranging the circuit so that the difference in capacity of two measuring capacitors is balanced by the balancing capacitor.

Fig. 10 shows the "Capacity Dynalog." It operates with a standardized set of components and a 1.7-megacycle frequency. In its standard form this circuit operates on a 5-uuf. variation of the 50-uuf. measuring capacitor. A full-scale range of 3 uuf. can be obtained. It is comparatively easy to operate with larger basic measuring capacities and correspondingly larger capacity variations. For narrower ranges of capacity variations, special design for the particular requirements is necessary. Experimental units have been operated to give full-scale instrument reading for as little as 0.05-uuf. capacity change.

BRIDGE CIRCUITS

In analytical circuits for measurement of static samples, bridge-circuit technique is commonly employed. In certain continuous industrial measurements also, there are advantages to the use of bridge circuits, particularly where low-frequency operation is desirable. Conventional circuits usually are used; 1,000-cycle operation is common; standard measuring and recording apparatus is applicable directly or with slight modification.

For a large proportion of continuous industrial applications, it is desirable to locate the primary measuring element some distance from the rest of the apparatus. There is a bridge-type circuit which is old but not well known, which facilitates the separation of the measuring capacitor and the rebalancing circuit. Fig. 11 illustrates this circuit. The measuring and rebalancing circuits are supplied from a transformer with a pair of output windings connected in series. Both the total impedance and the leakage impedance between windings of this transformer are low. The common point of the transformer windings is grounded.

Capacity to ground or leakage resistance to ground from the lead wire connecting one end of the transformer to the measuring capacitor is in effect a shunt across half the transformer. As any reasonable capacity or leakage has an impedance that is high compared to the low impedance of the transformer, this shunting has negligible effect.

The lead from the other side of the measuring capacitor connects to the grid of a vacuum tube. Any potential applied is amplified and operates the rebalancing motor and rebalancing capacitor to reduce this voltage to zero. Thus the potential of this lead is maintained at ground potential. As zero potential is applied to any capacity to ground or leakage to ground from this lead, reasonable values of capacity or leakage between this lead and ground have no effect on the measurement. Capacity variations of up to 10,000 uuf. between either or both leads and ground have no perceptible effect on spans as low as 100 uuf. A pair of ordinary flexible concentric cables with lengths to hundreds of feet can be used between the measuring capacitor and the rest of the apparatus. This circuit, of course, requires that both sides of the measuring capacitor be insulated from ground. Conventional circuits are applicable for the amplifier and balancing mechanism. There are a number of these units in operation using standard "Foxboro Resistance Dynalogs."

The major limitation on a circuit of this type is imposed by dielectric losses. It is possible to include in the balancing circuit either series or parallel resistance to provide exact balance for a specific loss factor in the measuring capacitor. However, if the losses in the measuring system vary, the

Continued on page 1484

ELECTRONIC TIMERS

By E. A. DEMONET and L. C. BOWER
The Western Union Telegraph Company, New York, N. Y.

Basic circuits and operation of typical timers which use both hot-cathode high-vacuum tubes and cold-cathode gas tubes are described. Curves permit rapid selection of *RC* values for any desired timing operation with a given gas tube.

TIMERS designed to produce and to recognize time intervals are becoming increasingly important in industry. This article discusses typical electronic timers used by the Western Union Telegraph Company, and also the means by which electrical connections are established between the timers and their external circuits. Western Union uses thousands of electronic timers which recognize when a desired condition (or an abnormality) has existed for a predetermined period, and which then either initiate another procedure or summon supervisors or technicians by visual and audible signals. Other electronic timers are used to produce timed circuit opens or discontinuities; still others are used to recognize these occurrences.

The electronic timer uses a vacuum or gas tube with a network of capacitors and resistors connected to the grid or starter anode (to obtain the timing desired), and usually a relay connected in the plate circuit of the tube to control external circuits. The timers are not influenced appreciably by surrounding temperatures or heat from previous operations and, in addition, they return almost immediately to their initial condition after release.

Electronic timers can be divided into two general classifications—those using "hot-cathode" high-vacuum tubes and those using "cold-cathode" gas tubes. The three types described in this paper have widely differing functions. One responds to signals of one duration, one produces signals of two durations, and the third responds to signals of two durations.

HOT-CATHODE HIGH-VACUUM TUBE

The hot-cathode vacuum-tube timer (Fig. 1) requires an external supply of electric energy to heat the cathode of the tube. In hot-cathode vacuum tubes, the plate current is proportional to the potential between the grid and cathode when the grid is above the cut-off point on its characteristic curve of grid potential vs. plate current. By changing the potential of the grid, the plate current can be varied from zero to maximum, the actual value depending on the tube employed and on the characteristics of the tube.

COLD-CATHODE GAS TUBE

The cold-cathode type of timer (Fig. 2) uses a 3-element (cathode, plate, and starter anode) tube containing an inert gas under low pressure. This type of tube does not require a continuously heated cathode to supply the electron emission. When the starter anode is made approximately 85 volts positive (for an OA4G tube) with respect to the cathode, ionization of the enclosed gas takes place, providing electrons and ions. The ions bombard the cathode, which then provides still more electrons. The electrons are attracted to the positive plate. The flow of electrons is the plate current. If the plate has a positive potential in excess of 60 volts with respect to the cathode, the tube "fires"—that is, the gas ionizes—and plate current flows.

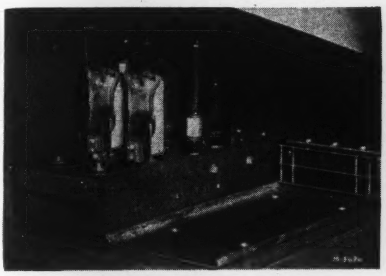


Fig. 1. Western Union hot-cathode timer which produces either of two timed intervals.

The starter anode is used only to initiate the flow of plate current. Unlike the hot-cathode grid-controlled vacuum tube, the starter anode of the gas tube loses control of the plate current once the tube fires; even if the starting voltage is removed from the starter anode, the tube continues to conduct.

The plate current reaches a maximum value as soon as the tube fires. In order to stop the flow of plate current, the cathode-to-plate voltage must be reduced so that the gas deionizes, or is "extinguished." The plate voltage at which the tube is extinguished depends on the type of tube (60 volts for an OA4G tube). The gas tube can be extinguished also by opening the plate circuit. This interrupts the current and causes deionization of the gas.

OPERATE INTERVAL

The same principle is used in circuits employing either high-vacuum or gas tubes to determine the *operate interval*. This interval is the time required to operate or to release the plate-circuit relay. A potential of correct polarity either is applied to or is removed from a network of capacitors and resistors connected to the grid or starter anode of the tube. The response of this network determines the interval.

There are three factors which affect this operate interval. The first is the firing time of the gas tube—or the cut-off time of the vacuum tube. The second is the operate or release time of the plate relay. These two factors can not be controlled much because they are functions of the component and are fixed at the time of design, when components are chosen. The third and most easily controlled factor is the value of the capacitors and resistors in the circuit connected to the grid or starter anode of the tube.

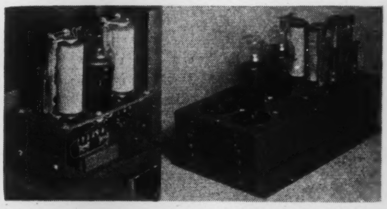


Fig. 2. Western Union cold-cathode timers. Timer on left responds in one timed interval. Timer on right responds in two different intervals.

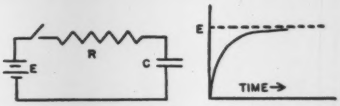


Fig. 3. Circuit for charging a capacitor through a resistor, and a curve of charging voltage (measured across capacitor).

Tube Response.—The firing time is in the order of microseconds for hot-cathode vacuum tubes, and up to 5 milliseconds for cold-cathode gas tubes. Thus, unless the requirements for the timer include a high degree of accuracy or an operate interval in the order of milliseconds, the firing time of the tube is unimportant.

Relay Response.—A practical relay is limited as to (1) its operate time, (2) the range over which it can be varied, and (3) the maximum time the relay can consume in operation. The operate time of standard switching-type relays provides for a delay of approximately 4 to 10 milliseconds, which is the time required for the relay to operate. Here again, the choice of relay depends on the accuracy and length of time desired for timer operation. As the time delay introduced by a given relay depends on the pressure of the contact-spring complement and on the magnetic circuit, it is difficult to

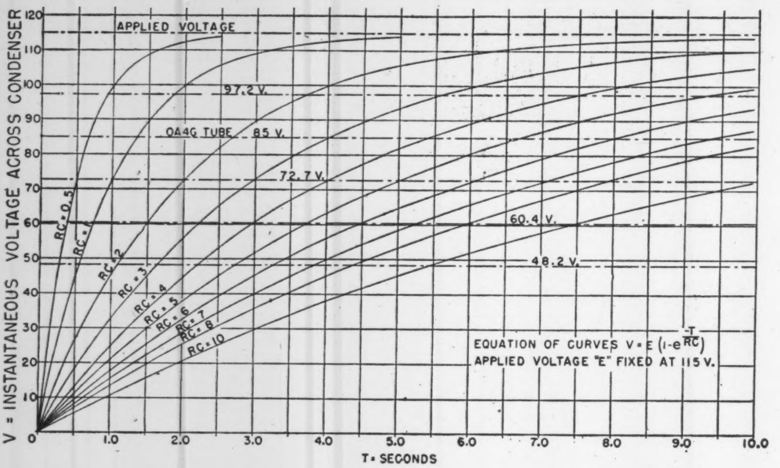


Fig. 4. Instantaneous capacitor voltage while charging, for various values of RC.

adjust the relay for a particular operate time.

R-C Response.—The third factor, the response of the R-C circuit, is most convenient for establishing and controlling the operate interval. By proper selection of resistor and capacitor values, large or small time intervals can be obtained, the lower limit being set by the relay and tube response.

When a capacitor is charged through a resistor (Fig. 3) the capacitor charges rapidly at first, and then approaches the value of the applied voltage at a rate depending on the values of the resistance and capacitance employed. Conversely, if a charged capacitor is discharged through a resistor, it takes a certain amount of time, depending on the values of resistance and capacitance, to discharge the capacitor.

The rate at which a capacitor charges or discharges through a resistor is not uniform; it is greatest at the start and gradually becomes smaller. Although the *rate* varies, the time for a capacitor to charge or to discharge to exactly 63.2 percent of its final value is a constant, called the *time constant*, or *characteristic time* (T), of the resistor-capacitor circuit. The value of T is the product of the resistor (in ohms) and the capacitor (in farads), or $T = RC$.

Note that if a capacitor C which is charged to a voltage E is discharged through a resistance R, it will have a charge of (1-0.632) E, or 0.368 E, in RC seconds after the start of the discharge.

Formula for Exponential Charging.—The formula for the curve in Fig. 3 is:

$$V = E\ (1 - e^{-kt}), \tag{1}$$

where

V = voltage across the capacitor at any time, t.
t = time in seconds from the instant that voltage E is applied
E = applied voltage
e = 2.718 = the base of natural logarithms
k = a constant

The value of the constant, k, for the circuit in Fig. 3 is $1/RC$.

Therefore,

$$V = E\ (1 - e^{-t/RC}) \tag{2}$$

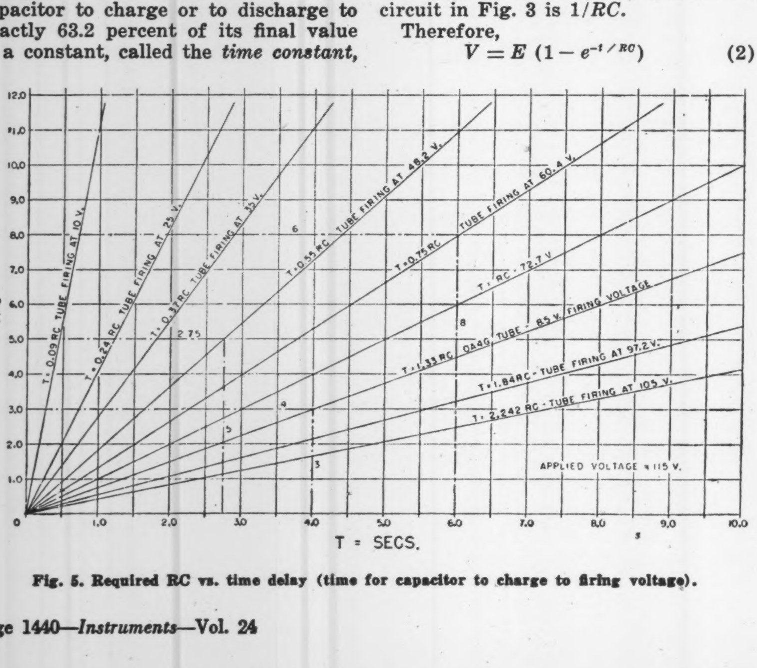


Fig. 5. Required RC vs. time delay (time for capacitor to charge to firing voltage).

Note that when $t = RC$ seconds:

$$\begin{aligned} V &= E\ (1 - e^{-1}) \\ &= E\ (1 - 1/2.718) \\ &= 0.632E \end{aligned}$$

This proves that no matter what the applied voltage, at the time $t = RC$ seconds, the voltage across the capacitor of the RC circuit is 63.2 percent of the applied voltage.

Formula (2) has four variables—V, E, t, and RC. If the value of E is fixed at the average line voltage of 115 volts, the three remaining variables can be plotted, resulting in the family of curves for RC shown in Fig. 4. Each curve in Fig. 4 is a plot of V vs. t for a given value of RC. This set of curves shows that with a fixed applied potential, the smaller the RC value, the faster the voltage across the capacitor builds up.

A horizontal line is drawn across the graph at 63.2 percent of 115 volts, or 72.7 volts. Note that this line intersects each RC curve at $t = RC$. At 85 volts (the firing voltage for an OA4G tube), another horizontal line is drawn, intersecting each RC curve at another point. By taking a series of horizontal lines at selected voltages (the firing voltages for different tubes), the set of curves on Fig. 5 is obtained.

Each curve in Fig. 5 shows the time in seconds required to fire the given tube with a given RC circuit. This set of curves shows that at a fixed applied voltage of 115 volts, the number of seconds required to fire a tube with a firing voltage higher than 72.7 volts (63.2 percent of 115 volts) is greater than RC seconds. Similarly, the time interval for a tube with a firing voltage less than 72.7 volts is less than RC seconds. The constant by which the RC must be multiplied in order to obtain the firing time is indicated on each curve in Fig. 5. For example, a tube firing at 105 volts fires in 2.242 RC seconds after the voltage is applied.

Fig. 6 shows curves of tube-firing voltage plotted against RC for discrete values of operate interval, or firing time. This graph is convenient for determining the value of RC required if the applied voltage is 115 volts, and if the firing voltage of the tube and the desired operate time are known. Interpolation can be made between the time curves in the vertical direction.

TYPICAL ELECTRONIC TIMERS

Timer Responding in One Interval.—Fig. 7 shows a typical circuit for a cold-cathode timer which responds in one timed interval after application of the input signal. The operation is initiated by relay E. It is desired to operate the plate-circuit relay, P, a given time after relay E operates. The contacts on relay P control the external circuit.

Fig. 7 is the circuit of the timer shown in Fig. 2. An 18-prong Jones plug recessed in its base mates with a Jones socket mounted on the rack or table. This makes the timer easy to replace.

The time between the operation of relay E and that of relay P is con-

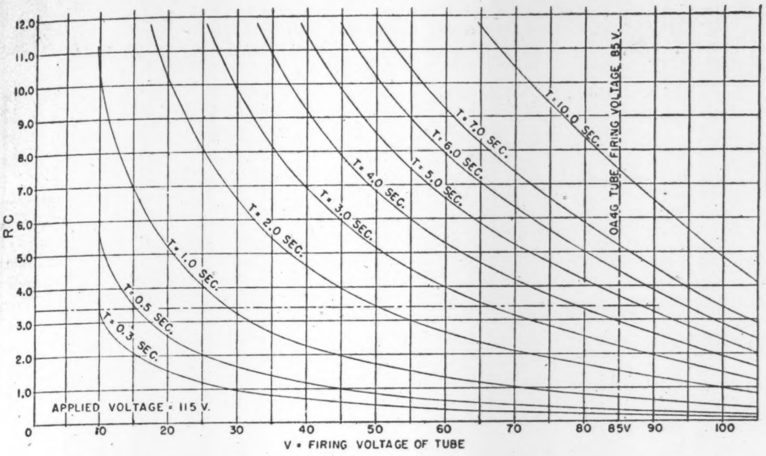


Fig. 6. RC vs. firing voltage of tube (also voltage at capacitor being charged).

trolled primarily by capacitor *C* and resistor *R*.

The 0.24-megohm resistor acts merely as a current limiter for protection of the starter anode. The 0.05-microfarad capacitor keeps the voltage at the starter anode from dropping at the instant the current starts to flow between the starter anode and the cathode. Without this capacitor, the voltage at the starter anode would drop when electrons flow from the cathode to the anode and through the 0.24-megohm resistor. The capacitor charges when relay *E* operates and, at the instant the current starts to flow between the starter anode and the cathode, the 0.05-microfarad capacitor discharges to increase the current flow. This assures the immediate firing of the tube. The time constant of the 0.24-megohm resistor and the 0.05-mf. capacitor is much smaller than that of the *RC* combination so that their delaying operation is negligible by comparison.

The values of capacitor *C* and resistor *R* determine the length of time between the operation of relay *E* and the firing of the tube. By selecting values of *R* and *C*, the firing of the tube (and consequently the operation of relay *P*) can be delayed for a desired time after relay *E* operates.

Choice of RC.—It is desired to make the operate interval of the circuit in Fig. 7 be between 4 and 5 seconds. As the operate interval is in seconds, and as the tolerance on the time is not exacting, the firing time of the tube and the operate time of the plate relay can be neglected.

It is known that the firing voltage of the OA4G tube is about 85 volts. With this information, the correct *RC* value can be found from Fig. 6. On the vertical line above the firing voltage of 85 volts, interpolation between the curves of 4 seconds and of 5 seconds is made to determine the point for a delay of 4.5 seconds (half way between the 4-sec. and the 5-sec. curves). From this point, the desired *RC* is found by drawing a horizontal line to the *RC* axis and reading the result directly. It is seen that the product of *R* and *C* must be approximately 3.3.

The next consideration is what values to make *R* and *C* to obtain the 3.3 product. Although there is an unlimited number of values for *R* and *C* which equal 3.3 when multiplied together, the practical values and dimensions of standard manufactured resistors and capacitors must be taken into consideration. For example, capacitors larger than a few microfarads are large and expensive. Another consideration is the standard tolerance on the resistors and capacitors.

Assume that a 2-uf. capacitor is as large as is practicable to use. In order to obtain $RC = 3.3$, the resistor must be 1.65 megohms. As 1.65 megohms is not a standard-size resistor, the nearest standard size—1.8 megohms—is used, resulting in an *RC* value of 3.6. Fig. 6 shows that an *RC* value of 3.6 gives an operate interval of about 4.7 seconds with a tube which has an 85-volt firing voltage. This satisfies the requirements of the timer. If it is desired to make the operate interval exactly 4.5 seconds, an adjustable resistor must be used.

Timer Producing Either of Two Operate Intervals.—Fig. 8 shows the circuit for a hot-cathode timer which produces either of two timed intervals. If relays *E1* and *E2* are both operated, relay *P* operates 600 milliseconds later. If relay *E1* (but not relay *E2*) operates, relay *P* operates 2 seconds later.

The circuit of Fig. 8 is the schematic diagram of the timer shown in Fig. 1. It plugs into two rows of clips for easy replacement.

The 0.1-megohm resistor in series with the control grid of the 50L6-GT hot-cathode high-vacuum tube is a current limiter provided to protect the grid from excessive current, which could burn out the grid. The second, or screen, grid is connected to a positive voltage through a 10,000-ohm resistor, which provides the proper operating voltage for the screen grid. The 50L6 tube is constructed to "beam" electrons from the cathode to the plate. This permits rapid build-up of higher plate current than is possible with a triode. As a fairly large current is required to operate relay *P*, a "beam-power" pentode, such as the 50L6, is used in the circuit.

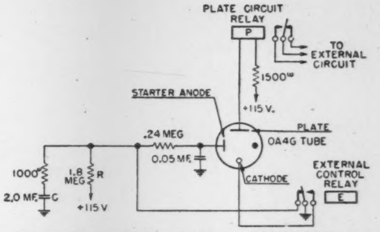


Fig. 7. Typical circuit for a cold-cathode gas-tube timer which responds in one timed interval.

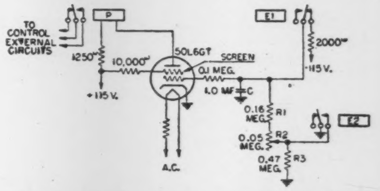


Fig. 8. Typical circuit for a hot-cathode vacuum-tube timer which produces either of two timed intervals.

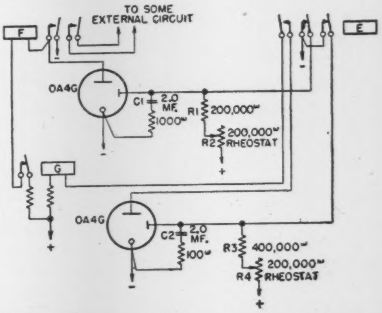


Fig. 9. Typical circuit for a cold-cathode gas-tube timer which responds to either of two timed intervals.

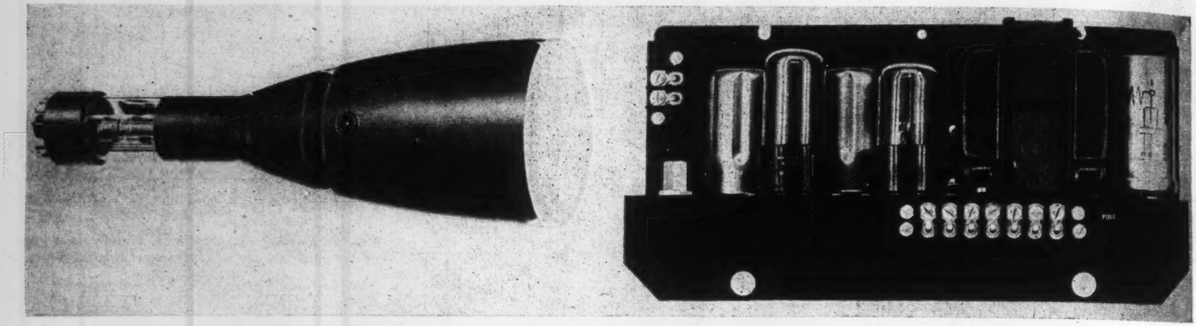
Before relays *E1* and *E2* operate, capacitor *C* is charged to a large negative potential through the 2,000-ohm resistor, which is connected to a negative 115-volt potential. Thus, the tube is normally cut-off. When relays *E1* and *E2* both operate, *C* discharges through *R1* and a part of *R2* to ground. As the grid potential rises to ground potential, the plate current increases to a value sufficient to operate relay *P*. The resistance of *R2* is adjusted so that the discharge rate of the capacitor is such as to make relay *P* operate exactly 600 milliseconds after relays *E1* and *E2* operate.

When relay *E1* (but not *E2*) is energized, capacitor *C* discharges through *R1*, *R2*, and *R3*. This increases the operate interval to 2 seconds.

The resistor *R2* is made variable to permit adjustment for aging of the tube, interchanging of tubes, variations due to manufacturing tolerances in the resistor and capacitor values, and supply-voltage variations.

Timer Responding To Two Timed Intervals.—Fig. 9 shows the circuit for a cold-cathode gas-tube timer which re-

Continued on page 1474



(Left) Dumont Type 5CPA cathode-ray tube, a commonly used industrial tube.
(Right) Electronic amplifier used in Bristol bridges and potentiometers.

INSTRUMENT ELECTRONICS

Vacuum tubes are ideal "valves." The diode, triode, tetrode, pentode, beam-power pentode, variable-mu tube, cathode-ray tube, and special u-h-f. tubes are used commonly in instrument circuits.

By
MILTON H. ARONSON
Managing Editor
Instruments

V. VACUUM TUBES

Tubes are Valves

In England, all electron tubes are called valves. The term "valve" is more descriptive than the American term "tube" because an electron tube is simply a fast-acting valve which controls current.

There are two types of electron tubes—*vacuum* and *gas*. Both consist of an evacuated shell containing elements which produce and control a current. The gas tube differs from the vacuum tube in that it contains a small amount of low-pressure gas, which is inserted after the envelope is evacuated. The vacuum tube sometimes is called a high-vacuum tube because the gas tube is a "vacuum tube" also. In this discussion, however, the term "vacuum tube" refers to non-gaseous high-vacuum tubes.

All electron tubes can be considered as rapidly-acting valves—the vacuum tube as a throttling-type valve; the gas tube as an on-off valve. Their great utility arises from the fact that the electron has such small mass that it can be started and stopped almost instantaneously and with little expenditure of power. Hence the electron tube is the ideal "valve."

Diodes

The simplest type of vacuum tube is the diode (Fig. 5-1), which contains two elements—a cathode and a plate, or anode. The filament (or heater) serves only to heat the cathode. Connections to the elements usually are through the base of the tube.

When heated, the cathode emits electrons. When the plate is not more positive than the cathode, the emitted negatively-charged electrons hover near the cathode in a cloud called the *space charge*. When the plate is at a potentional more positive than the cathode, the negatively-charged electrons in the space charge are attracted to the positive plate, as shown in Fig. 5-2. The flow of electrons is a current, which can be measured by a milliammeter in the plate circuit of the diode.

The cathode is the emitter of the electrons in the circuit. The electrons flow from cathode to plate to battery and then back to cathode. This is the complete *plate circuit* through the *plate current* flows. Any device through which it is desired to send current can be inserted in the plate circuit; the load in the plate circuit can be a resistor, a motor field-coil winding, or any current-carrying device.

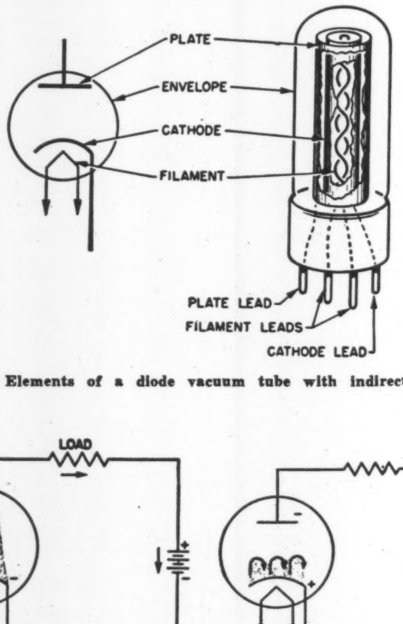


Fig. 5-1. Elements of a diode vacuum tube with indirectly heated cathode.

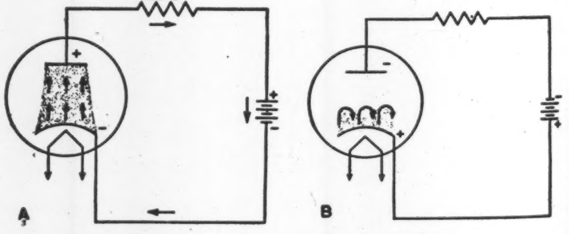


Fig. 5-2. Effect of plate potential on diode current. A, plate positive with respect to cathode; B, plate negative with respect to cathode.

ANSWERS TO QUIZ IV.—IMPEDANCE AND RESONANCE

4-1.	(c)	4-6.	(a)	4-11.	(d)	4-16.	(d)	4-21.	(c)
4-2.	(a)	4-7.	(d)	4-12.	(a)	4-17.	(b)	4-22.	(a)
4-3.	(d)	4-8.	(c)	4-13.	(c)	4-18.	(c)	4-23.	(b)
4-4.	(b)	4-9.	(a)	4-14.	(a)	4-19.	(c)	4-24.	(b)
4-5.	(d)	4-10.	(c)	4-15.	(c)	4-20.	(a)		

Test items for — V. Vacuum Tubes — page 1483.

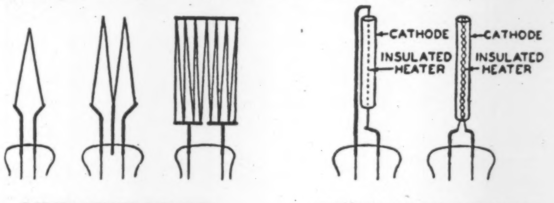
Thermionic Emission

The billions of free electrons in a metal are in a state of continuous vibratory motion with a velocity that increases with temperature. When the temperature of the metal is made sufficiently high, and when the atmospheric pressure around the metal is made sufficiently low, the free electrons can escape from the metallic surface, just as vapor escapes from the surface of a hot liquid. Thus, when sealed in an evacuated envelope, a heated emitter becomes a practical source of electrons. It can emit currents of hundreds of milliamperes. The emission of electrons from the heated emitter, or cathode, is called thermionic emission.

Types of emitters. Only a few substances can be heated to the high temperatures that are required to produce satisfactory thermionic emission. Tungsten, thoriated-tungsten, and oxide-coated emitters are the substances commonly used in vacuum tubes.

Tungsten has great durability as an emitter but requires a large amount of heating power and a high operating temperature for satisfactory emission. Tungsten cathodes are used in high-power vacuum tubes.

A thoriated-tungsten emitter has a thin layer of thorium on the surface of the tungsten. Such a cathode has greater electron emission at a lower operating temperature than a cathode of pure tungsten. Thoriated-tungsten emitters are used in tubes that are operated at plate voltages from 500 to 5,000 volts.



DIRECTLY HEATED CATHODES (FILAMENT TYPE)

INDIRECTLY HEATED CATHODES (HEATER TYPE)

Fig. 5-3. Types of cathode construction.

Oxide-coated emitters consist of a metal, such as nickel, coated with a mixture of barium and strontium oxides, over which is formed a thin layer of metallic barium and strontium. The electrons are emitted from the surface layer of barium and strontium. This type of emitter has long life and a high emission efficiency. It is used in most instrument-circuit and radio-receiver tubes.

Heating the cathode. Cathodes can be heated either directly or indirectly, as shown in Fig. 5-3. A directly heated, or filament type, cathode is heated by passing the heating current through the filament, which emits the electrons. An indirectly heated cathode is heated by passing heating current through a heating element, which in turn heats the cathode by radiation and conduction. The cathode, which does the emitting, is a metal cylinder with the filament extended through the center; it is insulated from the filament.

As the temperature of a cathode is raised, the cathode emits more electrons. However, if too much heating current flows through the filament it burns out. A safe filament current, together with the voltage to produce this current, is specified by the manufacturer. When you operate tubes, be sure to use only the specified heater voltage. Tubes have designation, or type, numbers. The number preceding the first letter of many tubes indicates the filament voltage to be used. For example, a 6V6 tube requires a filament voltage of 6.3 volts; a 50L6 requires 50 volts; a 35Z5 requires 35 volts.

CORRECTIONS

In last month's serial, two typographic errors appeared:

(1) The second sentence in the first paragraph under TRANSIENTS AND R-C CIRCUITS on page 1302 should read: "At the instant the switch is closed, the capacitor starts to charge *to* the voltage of the battery."

(2) The first test item should read: "4-1. A transducer is a device which"

The filament is supposed to heat the cathode but not to affect the plate current in any other way. Alternating current is used often to heat the filament because of the ready availability of a-c. power. However, one disadvantage of using a-c. power to heat the filament is that the plate current has an undesired 60-cycle "hum" component. As indirectly cathodes with a-c. operated filaments cause less a-c. hum than a directly heated cathode, indirectly heated cathodes are used in most a-c. operated amplifier circuits. However, as the directly heated emitter is more efficient and requires less heating power, it is used in many portable battery-operated circuits.

Another advantage of the indirectly heated cathode is that there is no electrical connection between filament and cathode (Fig. 5-4). In many circuits the cathode must be operated at a potential different from that of the filament. However, as the filament must be close to the cathode in order to heat it, the voltage difference between cathode and filament must not be large enough to cause a breakdown of the insulation between them. There is a peak heater-cathode voltage rating for each type of indirectly heated tube. This rating is the highest instantaneous voltage that a tube can safely withstand between its heater and cathode before arcing occurs. The peak heater-cathode voltage for a given tube usually is given in tube manuals on the data pages for the tube. It is about 300-500 volts for conventional diodes, and about 90 volts for most voltage amplifier tubes.

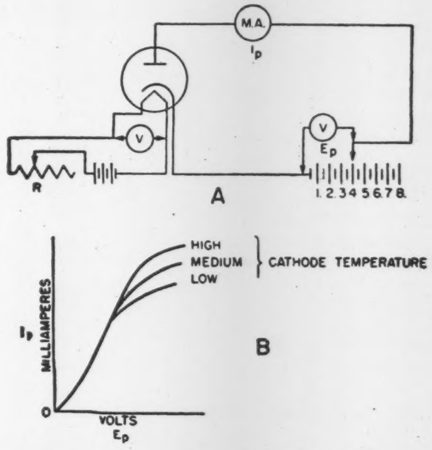


Fig. 5-4. Diode operation. A, circuit for making characteristic curve; B, characteristic curve.

Diode Operation

When the plate of a diode is made more positive than the cathode, the negatively charged electrons emitted by the cathode are drawn to the more-positive plate. The electrons flow from the cathode to the plate inside the tube envelope and back to the cathode through the battery only when the plate is more positive than the cathode. However, if the plate is made negative with respect to the cathode, no plate current flows because the emitted electrons are repelled instead of attracted by the plate. Thus, the diode is (1) a conductor when the plate is positive with respect to the cathode and (2) a nonconductor when the plate is negative with respect to the cathode. This property of the diode permits the tube to be used for two useful functions—rectification and detection. Both functions, which will be described in detail later, depend on the fact that the diode can conduct current in only one direction. It is a one-way valve for current.

Characteristic Curve

The action of the diode can be seen from its characteristic curve, which is a curve showing the current through the diode for different potentials applied across the diode. Fig. 5-4 shows a circuit for varying the plate potential and the filament temperature. The current through the diode is the plate current (I_p); the plate voltage (E_p) is the voltage *difference* between cathode and plate. Fig. 5-4 shows three characteristic curves, which were made by plotting I_p against E_p at three cathode temperatures.

Note that the curves are linear over a range of plate current and voltage. The diode is like a low resistance when the current and voltage are in this range. The upper end of the linear portion is called the *saturation* point. Diode rectifiers usually are operated only over the linear portion of the curve—that is, a plate voltage higher than the saturation voltage seldom is applied to the diode.

When the plate voltage is higher than the saturation voltage, the flow of plate current is practically independent of the plate voltage but is a function of cathode temperature. However, at lower values of plate voltage, the plate current depends only on the plate voltage and is relatively independent of the temperature of the filament. This is because although the number of electrons emitted from the cathode depends only on the cathode temperature (and the pressure of its surrounding atmosphere), the plate current is formed by attracting more or less electrons from the space charge, which acts like a reservoir of electrons.

Rectification

If the battery in Fig. 5-2 is replaced by an a-c. generator, the plate is driven alternately more positive and more negative than the cathode. However, the current through the output load resistor flows only when the plate is positive. Hence the current through the resistor is unidirectional, or rectified. This is what makes the diode a rectifier.

Peak inverse voltage. When the diode rectifies an alternating current, the plate is made alternately more positive and then more negative than the cathode. No current flows when the plate is more negative than the cathode. However, if the plate is made too much more negative than the cathode, undesired electric arcing occurs between plate and cathode.

The peak inverse voltage of a diode is the maximum voltage that the plate can be made more negative than the cathode before arcing occurs between cathode and plate. The voltage is called inverse because normally the plate is more positive than the cathode.

Plate resistance. The d-c. plate resistance of the diode can be defined from Ohm's law. At any one point on the characteristic curve there is one plate current (I_p) for a given plate potential (E_p). The d-c. plate resistance (R_p) of the diode at that point, which is the d-c. resistance of the diode from cathode to plate, is

$$R_p = E_p/I_p.$$

The d-c. plate resistance of most diodes is from 100 to 500 ohms.

The resistance of the tube to a.c. (plate impedance or dynamic resistance) can be found from the slope of the characteristic curve, as explained previously. Over the linear portion of the curve, it usually is about one half to two thirds the d-c. plate resistance.

When the plate potential of a diode is less than its cathode potential, the diode does not conduct—that is, I_p is zero. Therefore, the plate resistance is infinitely large. The diode then acts like an open switch. When the diode has an a-c. plate voltage, the plate swings positive and then negative; the diode then acts like a switch that opens and closes rapidly. Another way of saying the same thing is that the diode changes rapidly from a high impedance (when nonconducting) to a low impedance (when conducting). Thus the diode can be considered as either a switch or a rapidly-changing resistance.

Although all diodes have I_p-E_p curves shaped as in Fig. 5-4, the values of I_p and E_p differ for different tubes. Table VI shows tube data for some typical diodes. The word MAX. refers to the saturation point on the curve or to maximum safe values.

Note that the filament and plate currents of the type-5U4-G tube are larger than the currents of the type-6H6 tube. The former tube is used in power supplies to deliver fairly large currents to electronic circuits. The latter tube is used mainly as a detector of signals.

TABLE VI.—DIODE DATA

	5U4-G	6H6
Filament voltage	5.0 v.a.c.	6.3 v.a.c. or d.c.
Filament current	3.0 amp.	0.3 amp.
A-c. plate voltage	450 v. (max.)	150 v. (max.)
Peak plate current	675 ma. (max.)	48 ma. (max.)
Typical plate impedance	75 ohms (min.)	40 ohms (min.)
Peak inverse voltage	1550 v. (max.)	420 v. (max.)
D-c. heater-cathode potential		330 v. (max.)

TRIODES

The triode is a diode with a third electrode. The third element, called a *control grid,* is placed between the cathode and the plate (Fig. 5-5). The new element—the control grid—is a fine-wire spiral between the cathode and the plate. Note that the control grid has spaces between the turns of wire. These spaces are large enough to permit the electrons to flow from the cathode to the plate. The control grid makes amplification possible.

Operation

The grid controls the number of electrons flowing from the cathode to the plate. In a diode, current flow is controlled only by changing the temperature of the cathode—which is seldom done—or by changing the plate potential. As can be seen from the characteristic curve of the diode, the plate potential must be changed greatly to change the plate current from saturation to zero. A triode can do this with a small change in potential of the control grid because the grid is close to the cathode.

If the grid is given a small potential, *negative with respect to the cathode,* the negative potential on the grid repels some, but not all, of the electrons flowing from the cathode to the plate. If the grid is made more negative, fewer electrons will flow. The potential of the grid *with respect to the cathode* is called the *grid bias.*

Fig. 5-6 shows how the grid controls the plate current. In Fig. 5-6,C the grid bias is zero. The grid does not affect

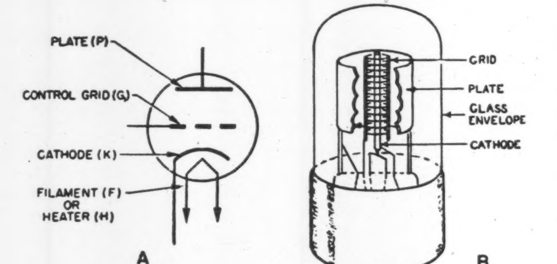


Fig. 5-5. The triode. A, schematic; B, construction; C, operation.

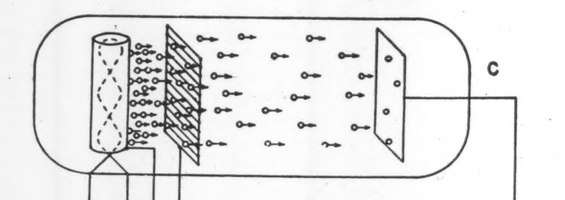


Fig. 5-6. Effect of grid potential on plate current. A, high negative bias; B, low negative bias; C, zero bias.

the electrons; the plate current flows as in a diode. In Fig. 5-6,B the bias is made slightly negative. As the electrons are negative, some of the electrons emitted from the cathode are forced back, and only a few have sufficient energy to reach the plate. In Fig. 5-6,A the grid bias is made very negative. The repelling force of the negative grid drives all the electrons back toward the cathode, and the plate current is stopped completely. The advantage of a triode over a diode is that a small change in grid potential can control the entire plate current.

The grid usually is operated at a potential that is negative with respect to the cathode. As the grid is more negative than the cathode, few electrons strike the grid wires on their way to the plate. Hence the grid current, I_g, is only a few microamperes. This means that the power required to drive the grid (change the grid potential) is negligible. This is important because signals of large powers can be produced in the output plate circuit with a signal of low power in the input grid circuit. Hence the tube is a power and voltage amplifier.

If the grid is made more positive than the cathode, the electrons flow to the grid. The grid then has considerable grid current and loses control of the plate current.

It is important to note that the current in the tube is controlled by the potential difference between the grid and cathode—that is, the grid bias. However, in a triode the plate current depends also on the plate potential, which is the potential between plate and cathode. Hence the characteristic curves which illustrate triode operation must show three variables—plate current (I_p), plate voltage (E_p), and grid voltage (E_g).

Characteristic Curves

In order to show three variables on one curve, it is necessary to show a family of curves, as in Fig. 5-7. Each curve is made by plotting plate current versus grid potential for a fixed plate potential (Fig. 5-7,A). Several such curves are a family of curves, as shown in Fig. 5-7,B.

The same information can be plotted by plotting plate current versus plate potential for several fixed grid potentials. This family of curves is shown in Fig. 5-8.

The family of E_p-I_p curves contains the same information as the E_g-I_p curves, but in different form. Note that either set gives the operating conditions of the tube. For example, if the 6C5 triode has a plate potential of 300 v. and a grid potential of −12 v., the plate current is 5 ma. The E_p-I_p curves usually are shown in vacuum-tube manuals.

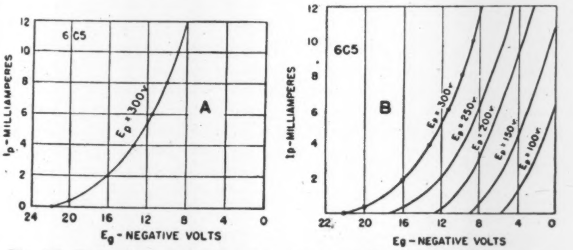


Fig. 5-7. E_g-I_p characteristic curves of a type-6C5 triode. A, one curve; B, family of curves.

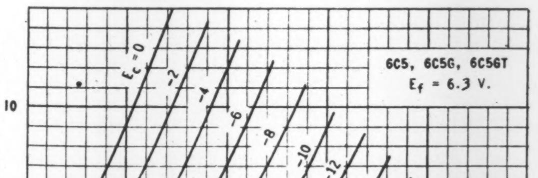


Fig. 5-8. E_p-I_p characteristic curves of a type-6C5 triode.

The curves are known as *static* characteristic curves because d-c. potentials are used to make the curves. In practice, vacuum tubes are used mostly with a-c. potentials superimposed on certain fixed d-c. potentials. However, the static curves can be used to show how the vacuum tube works with a-c. as well as d-c. signals, as will be explained later.

Amplification Principle

Fig. 5-9 shows a conventional triode amplifier. Although the grid always is negative, it can be raised or lowered in potential by applying a signal across the input resistor. Suppose that a piezoelectric crystal connected across the resistor produces a 1-volt positive signal. This positive signal causes an increase in plate current of, let us say, one milliampere. If the output load resistor in the plate circuit is 10,000 ohms, the 1-ma. *change* in plate current causes a 10-volt *change* in potential across the resistor. As a 1-volt input signal causes a 10-volt output signal, the gain of the amplifier stage is said to be 10.

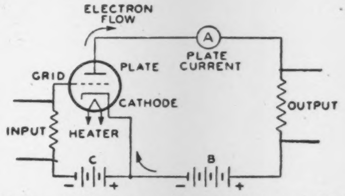


Fig. 5-9. A triode amplifier stage. Typical plate potential: 300 v.; control grid: minus 10 v.; cathode: zero or ground potential.

The gain of a stage depends on a number of factors—the plate potential, grid potential, and plate load. The maximum possible amplification of a triode is called the *amplification factor*, or *mu*, of the tube.

Note that a positive signal causes more plate current, which in turn causes the plate potential to drop. Hence the output signal is negative when the input signal is positive, and vice versa. Therefore, *there is a 180-deg. phase change between the input and output signals of a single-stage vacuum-tube amplifier.* Note also that the battery or source that produces the negative grid bias is called a "C" battery or supply; that which supplies the positive plate potential is called a "B" supply; that which supplies the filament power is called an "A" supply.

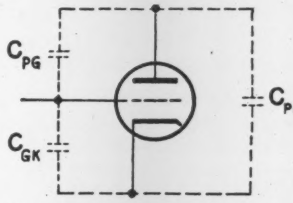


Fig. 5-10. Schematic representation of the interelectrode capacities of a triode.

The triode usually is operated with a resistor or inductor in the plate circuit, as shown in Fig. 5-9. The current flowing in the plate circuit causes an IR or an IX_L voltage across the load. This is the source of the output signal.

Dynamic Characteristics

Although the operation of a tube is shown by the characteristic curves, the important dynamic characteristics (a.-c. operation) are amplification factor, plate resistance, and transconductance.

Amplification factor. The amplification factor, which is the maximum possible gain, is defined as the ratio of a change in plate voltage (output signal) to the change in

Continued on page 1478

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Response Rate of Primary Temperature-measuring Elements

WASHINGTON, D. C.—The rate of response of temperature-measuring devices is important in jet-engine operation. According to Technical Report 1474, A. I. Dahl and E. F. Fiock of the National Bureau of Standards have developed apparatus (Fig. 1) which determines the rate of response of jet-engine temperature elements under conditions approximating those in the combustion stream. Response times as short as 0.02 second have been measured for thermocouples, resistance thermometers, and thermistors.

The rate of response, or CHARACTERISTIC TIME, of a temperature element is the time required by the element to undergo 63.2 percent of the total change in temperature to which it is suddenly subjected. This characteristic time depends on the mass, surface area, and heat capacity of the element, and on the rate at which heat is transferred to the element from the gases flowing through the engine. Heat can be transferred to the element by radiation, convection, or conduction. In jet engines the heat is transferred by convection. The Bureau, therefore, developed a system for studying characteristic time in which heat is transferred primarily by forced convection.

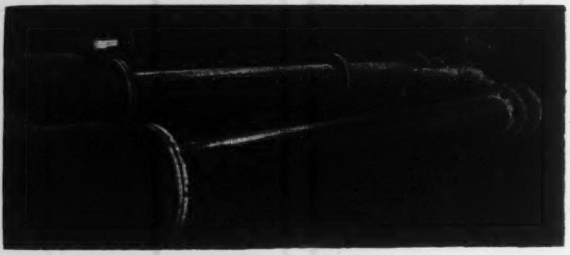


Fig. 1. Equipment for measuring the response of primary temperature elements.

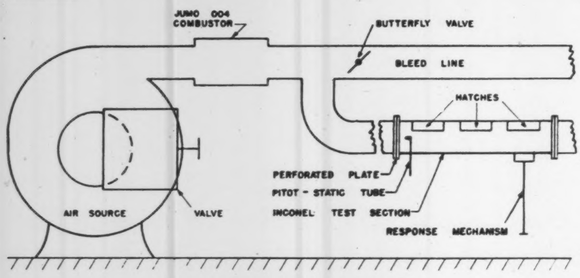


Fig. 2. Diagram of equipment.

The apparatus (Fig. 2) consists of a jet-engine combustor, or burner, with provision for mounting instruments in the exhaust gas stream, and a device for producing rapid changes in the temperature of the mounted test instrument. A blower supplies air to a single Juno 004 turbo-jet engine combustor. Exhaust gases from the combustor pass through two 90-degree turns, through a perforated plate, and then through 10 feet of straight pipe before reaching the test section, which has three hatches for mounting instruments. The turns in the duct system prevent exposure of any instrument to direct radiation from the flame.

The gas temperature and flow rate at the combustor outlet are controlled by means of a valve at the inlet to the compressor and by adjusting the fuel pressure. A bleed line containing a butterfly valve provides an auxiliary control of the flow in the test section. Pressures observed with pitot-static tube, together with the known value of gas temperature, permit calculation of the mass flow rate in the test section.

For measuring rate of response, the temperature of the gas surrounding the test element must be changed suddenly. This cannot be accomplished with sufficient rapidity by controlling the combustor. Therefore, apparatus was developed for quickly immersing the element without altering the steady flow of exhaust gas in the test section. An Inconel tube, projecting vertically upward through the test section (Fig. 3) is held in position around the test element by a release plate. Cold air flows through the tube. When the release plate is pulled out of the way, a spring suddenly removes the tube, exposing the element to the hot gas of the main stream almost instantaneously. During the downward movement of the tube, the supply of cold air is stopped automatically. In this way a test element at a known, moderate temperature (controlled by the air rate through the Inconel tube) can be brought in contact with exhaust gas at any given temperature and at any mass flow rate within the capacity of the system.

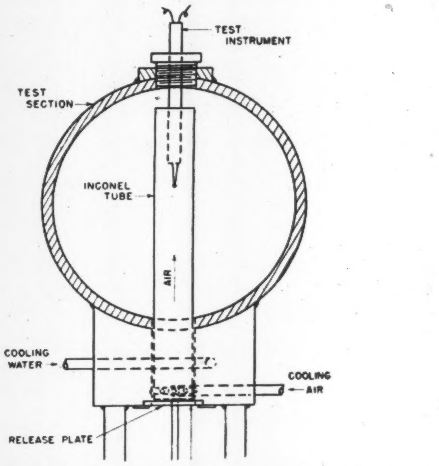


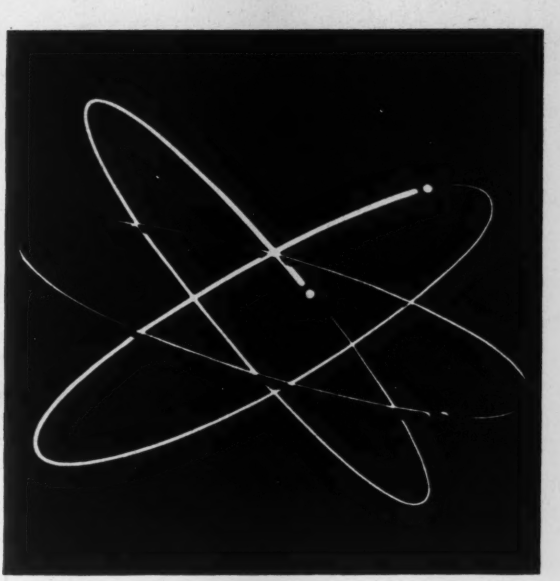
Fig. 3. Equipment for rapidly changing the temperature of the element.

The apparatus has been used at the Bureau to study the performance of temperature-sensing elements exposed directly to the gas stream, elements encased in metal and ceramic protection tubes, and elements imbedded in insulating materials such as quartz and beryllia.

Ultrahigh-frequency Amplifier

DAYTON, Ohio.—A radio frequency amplifier for ultrahigh frequencies was the subject of a paper presented at the Airborne Electronics Conference by B. F. Tyson and J. G. Weissman of the Physics Laboratories, Sylvania Electric Products Inc., Bayside, N. Y. The amplifier has a frequency range from 475 to 900 Mc., and uses a Type 5768 disk-seal planar triode in a grounded-grid circuit. The small size and double-end construction of the tube make it suitable for concentric-line circuitry. Its plate-to-cathode capacitance is only 0.015 mmf. and it pro-

first *all-electronic control*



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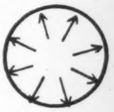

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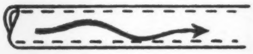

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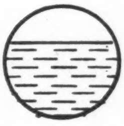

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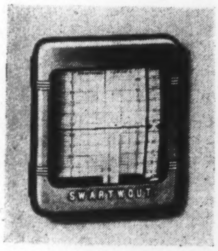
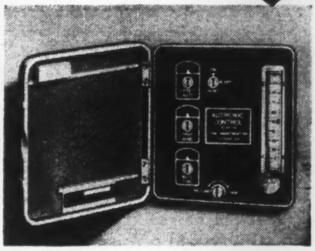




Swartwout *Autronic* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO vides a transconductance of 6500 micromhos with 8-ma. plate current.

Low cathode impedance of the 5768 triode permits direct feeding of the cathode input from a 50-ohm antenna line with mismatch loss less than 2 db. Output from the amplifier, at an impedance level of 50 ohms, is picked up by a small loop coupled to the tuned plate line. The power gain is about 16 with bandwidth between 6 and 12 mc. The r-f. amplifier used in the head end of a receiver reduces local-oscillator radiation by a factor of about 500.

Stick-force Indicator for Aircraft

WASHINGTON, D. C.—An instrument which automatically indicates the force applied to the control stick of an airplane has been developed at the National Bureau of Standards, according to Technical Report 1447. The new instrument makes use of the flexure in a cantilever spring in the stick handle. It is unaffected by ordinary fluctuations of aircraft battery voltages, and permits photographic record of stick-force indications.

In the new device, the standard stick handle is replaced temporarily by another containing the sensitive element—a cantilever spring whose deflection in two mutually perpendicular directions is measured. These deflections control voltages which operate a remote dual-pointer indicator by means of d-c. synchros (Selsyns).

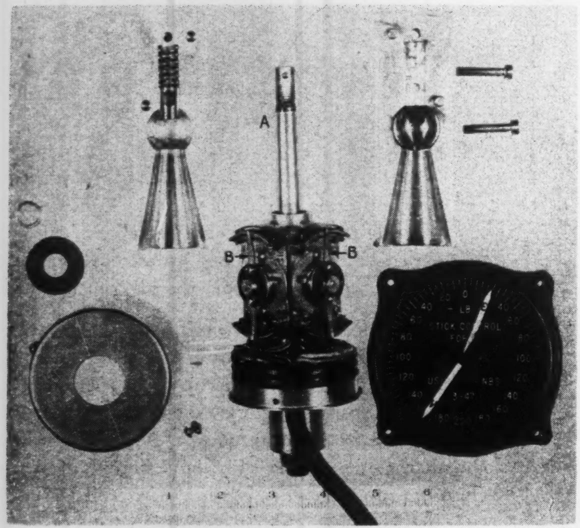


Fig. 1. Components of the NBS stick-force indicator.

The cantilever spring is a vertical rod of circular cross-section (Fig. 1) whose lower end is held firmly in the base of the unit. At the top of the rod a sphere is attached. About the sphere is clamped the cylindrical handle, thus localizing the application of force by the pilot at one point. Flexure of the rod is then a measure of the transverse force exerted through the handle and spherical joint.

When the rod is bent by the application of a force at the handle, it deflects one or both of two flat-spring strips mounted vertically beside the rod. The strips are attached at the lower end but are free at the upper to swing out with the rod as it bends. The flat strips are mounted in vertical planes which are at right angles. Outward or inward motion of either of the strips moves a lever attached to the brush shaft of the corresponding synchro transmitter (Fig. 2), causing rotary motion of the brushes of the transmitter. The voltages thus produced are transmitted to two commercial d-c. synchro indicators, which show motion in the two perpendicular directions. Both indicators are housed in one case having a single scale and graduated directly in pounds of force. The equipment weighs about 3 pounds.

The instrument is calibrated by hanging weights from a handle held in a horizontal position.

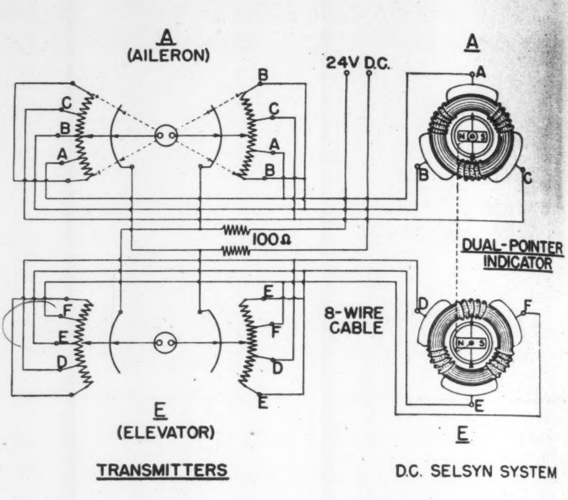


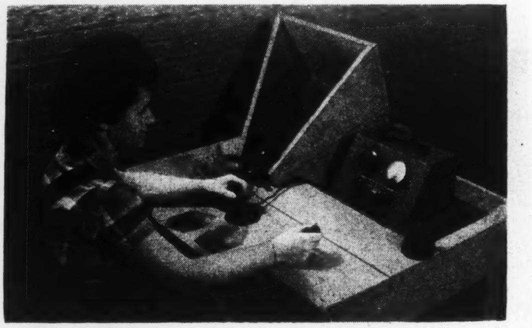
Fig. 2. Components of the synchro transmitter and receiver.

Tests of a typical instrument show a maximum hysteresis of about 2 percent of full scale. Thus the uncertainty in reading is about 1 percent of full scale. The calibration curve deviates about 2 percent from linearity; sensitivity is about 0.5 percent of full scale.

Magnetic Comparator Separates Bolts

ROCK FALLS, ILL.—A GE magnetic comparator, installed in a specially-designed test bench at Russell, Burdsall & Ward Bolt and Nut Company, Rock Falls, Ill., enables one operator to separate mixed bolts at a rate of 2200 an hour.

Unseparated bolts previously were sold at the classification of the lowest grade material in the mix, at considerable loss. To eliminate this, the company had to separate large numbers of bolts from mixes of differing material, a costly and time-consuming process. To facilitate the sorting operation, C. K. Hayward, Chief Metallurgist of the company, designed and built a testing bench which incorporates the magnetic comparator.



Basically an impedance comparator, the device correlates, through the use of standard reference specimens, the chemical and physical properties of the bolts being separated with the electrical and magnetic characteristics. Variations are shown on an indicator. The comparator is recessed in the test bench to make it easy for the operator to see the indicator. The testing coil is set in flush with the bench top so that the operator does not have to lift the bolts into the coil, but simply drops them in.

In one recent instance, a customer rejected $7,500 worth of bolts because of mixed content. A single operator, using the comparator test facilities, was able to separate the entire lot of 150 kegs (each containing approximately 1500 bolts) at a rate of 2200 an hour.

STABILINE — *Automatic* VOLTAGE REGULATORS

Two types of STABILINE Automatic Voltage Regulators are offered by The Superior Electric Company to meet the requirements of maintaining constant a-c voltage to electrical equipment.

IE

IE51002R

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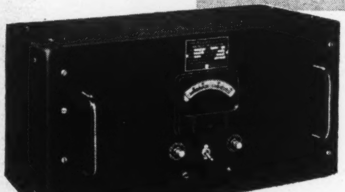
Type IE is a completely electronic unit with no moving parts. It provides almost instantaneous correction of line voltage or load changes. Waveform distortion never exceeds 3 per cent. Output voltage is held to within ± 0.1 per cent of nominal for wide line variations; to within ± 0.15 per cent of nominal for any load current change or load power factor change from 0.5 lagging to 0.9 leading. Type IE is versatile in application finding wide use in laboratory work, on test lines and as a component of other equipment where the most exacting voltage regulation is necessary. There are 28 standard models for 115 and 230 volts, 50 or 60 cycles, single phase operation ranging in capacity from ¼ to 5 KVA. Special units are available for higher frequency operation . . . to meet government agency specifications . . . or for unusual applications.

EM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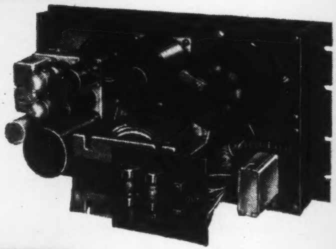
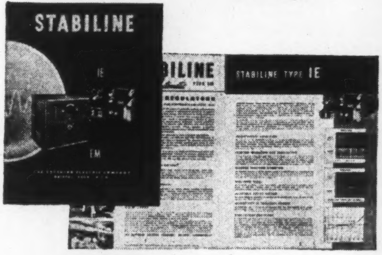

EM4102R

ELECTRO MECHANICAL

Type EM is an electro mechanical unit with a very sensitive detector controlling a motor-driven POWERSTAT variable transformer which feeds a buck-boost auxiliary transformer. Its outstanding advantages are zero waveform distortion and high efficiency. Type EM is most often used in the control of industrial loads. However; the demand of today's electronic equipment for constant voltage with absolutely zero waveform distortion necessitates the incorporation of a type EM as an integral part of the assembly. Type EM is offered in standard models for 115, 230 and 460 volts, 50 and 60 cycles, single and three phase duty in ratings from 2 to 100 KVA. Special units can be designed for higher frequencies, for conformance to government agency requirements and for individual needs.



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Panelboard showing Pyr-O-Vane and Protect-O-Vane Controllers for travelling oven at International Resistance Co.

LIKE all other products that bear the Honeywell nameplate, the Brown *Pyr-O-Vane* and *Protect-O-Vane* Electonic Controllers have established a reputation for sound design, trouble-free performance, and flexibility of application . . . all of practical importance to superintendents, engineers and instrument men.

Both instruments reflect years of experience in pyrometer construction. Galvanometer unit in each, incorporates a new high resistance circuit that provides an accuracy to ± 1% of total span. The electronic vane-type control unit provides a continuous *knife-edge* control, with snap action at the control point. Fluctuating line-voltages and changes in ambient temperatures and humidity have little or no effect on accuracy. Sensitivity of control is easily adjusted to meet individual control requirements or abnormal vibration conditions.

The *Pyr-O-Vane* is ideal for practically all temperature control applications. It is available with on-off, two or three position control.

The *Protect-O-Vane* is especially designed to protect electric and fuel-fired furnaces from excess temperatures. It automatically cuts off power and/or the fuel supply when a safe limit is exceeded. Flashing neon light warns of excess temperature . . . audible alarm may be sounded, if desired. Manual reset button will not re-start furnace until the temperature drops to a safe point.

Check These PERFORMANCE Features:

- √ *Snap-action control relay is highly responsive to changes in thermocouple emf.*
- √ *Separately enclosed high-resistance galvanometer is exceptionally stable and has high sensitivity.*
- √ *Vane-type electronic control provides continuous non-cyclic action.*
- √ *Control sensitivity easily adjusted to meet individual control requirements or abnormal vibration changes.*
- √ *"Fail-safe" design and thermocouple burn-out feature protects work load. Neon light warns of component failure.*
- √ *Plug-in design reduces maintenance, simplifies servicing.*
- √ *Universal case . . . for flush or surface mounting.*
- √ *Easily installed, low in cost.*

0 600 1000 1400 1800 2200
DEGREES FAHRENHEIT
Honeywell

Ruggedly constructed, simply designed units permit easy removal when servicing or replacement is required. Plug-in feature of galvanometer and control units eliminates damage to measuring and control elements . . . provides greater efficiency in making range changes or adjusting control to fit particular requirements.

Typifying the many advantages afforded by the *Pyr-O-Vane* and *Protect-O-Vane* electronic controllers, is the *plug-in* feature of their measuring and control units. Unit construction provides a definite *plus* factor in easy removal for servicing, or range change which may be made by simply plugging-in another galvanometer. All control units for any given voltage and frequency are identical and can be used for any scale range.

The two compartments of the case are provided with separate covers, completely protecting galvanometer and control unit from dust and moisture. The upper compartment houses the high resistance galvanometer while the lower contains the vane-type electronic control unit.

Take a *good look* at these unusual features . . . call in your local Honeywell engineer for a discussion of their utilization in your plant. Specification sheets Nos. 112 and 113 sent on request.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pennsylvania. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

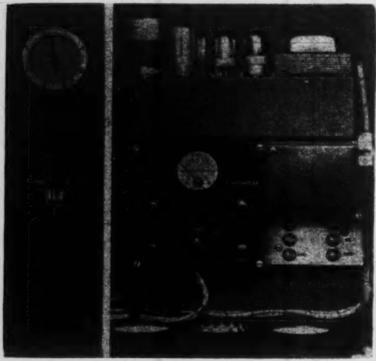
MINNEAPOLIS
Honeywell
Brown Instruments

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1521

pH Recorder



New pH recorder comprises electrode assembly, electrometer amplifier, and standard electronic potentiometer. Electrode assembly comprises glass electrode, calomel reference electrode, and resistance thermometer which corrects for temperature variation of glass electrode. Waterproof electrode assembly available in bronze or stainless steel. Sample is visible in non-clog flow chamber. Features include automatic zero set, balance control, compactness, complete shielding, high stability, accuracy of 0.1 pH, multi-point readings, and alarm-signal accessory.—*Cambridge Instrument Co., Inc.,* 3208 *Grand Central Terminal, New York* 17, *N. Y.*

Mention No. 1201 when filling out card.

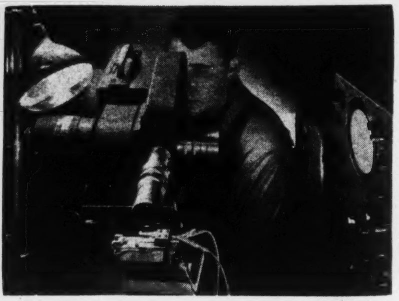
Instrumentation Camera

New "Varitron Model DR-2" camera is pulse-operated variable-sequence camera for aircraft and ground installations. Maximum picture frequency is 8 frames per sec. Frame frequency is controlled by timer, intervalometer, or any device which can make and break set of contacts. Camera is composed of four basic units—(1) electrically-operated shutter with maximum center opening of 1⅜ in. and speeds variable from 1/50 to 1/200 sec. by varying voltage input remotely, and with built-in electronic flash contacts, (2) camera body and data recording chamber, (3) film magazine, for either 35 or 70 mm. roll film in 100-ft. daylight loads or 200-ft. darkroom loads, and (4) remote control box, approx. 5 x 6 x 9 in. which houses shutter-speed control, indicator and control actuator, intervalometer, and switches and lamp to control and indicate remotely the operation of the camera counter to show frames exposed. Weight is 20 lbs.—*Photographic Products, Inc.,* 6916 *Romaine St., Hollywood* 38, *Calif.*

Mention No. 1202 when filling out card.

Dual-purpose Camera

New high-speed-camera modification permits mechanical and electrical aspects of subject to be recorded simultaneously on same film. Lens records images on cathode-ray oscillograph through back of film while mechanical aspects of subject are photographed on front. As film travels in vertical direction, horizontal-deflecting circuit alone is used. Film speed provides time base; exposure of oscillograph trace is continuous. Trace may be placed at any desired position. Modification can be added to "Kodak" or "Eastman Type III" high-speed cameras.—*Eastman Kodak Co., Rochester* 4, *N. Y.*



Mention No. 1203 when filling out card.

Audio Oscillator

New "Type 1214-A Unit Oscillator" is simple two-frequency oscillator (400 and 1000 cycles) useful as either modulating or general-purpose source. Output of 0.2-watt, with less than 3-percent distortion, is adequate for bridge-measurement work. Power supply is built in.—*General Radio Co.,* 275 *Massachusetts Ave., Cambridge* 39, *Mass.*

Mention No. 1204 when filling out card.

Sensitive Potentiometer

New potentiometer circuit measures spans as narrow as 100 microvolts; is applicable to laboratory investigations or production-line measurements of signals in the order of 0.1 microvolt. Can be used also for precise measurement of differential temperatures and in radiation pyrometry. Indicator, recorder, or controller can be used in conjunction with potentiometer.—*Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Ave., Philadelphia* 44, *Penna.*

Mention No. 1205 when filling out card.

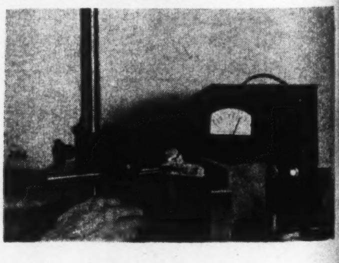
Differential Bridge Thermometer

New "Type BD Differential Speed Bridge" measures difference between two temperatures with accuracy. Unbalance of a-c. bridge is amplified and indicated on 0-500 microammeter. At high sensitivity, one division on meter is equivalent to less than 0.001 C. Uses include boiling or freezing point depression, calorimetric measurements, efficiency of radiators, etc.—*Weiller Instruments Corp.,* 95 *Broad St., New York* 4, *N. Y.*

Mention No. 1206 when filling out card.

Electronic Gage

New "Indi-Ac" electronic indicator checks setups and runout on machine and surface-plate work in shops, toolrooms, and gage rooms. Consists of induction-type gage head adjustably



Consistent Accuracy at Any Range

BS&B

CLIMAX

LIQUID LEVEL CONTROL

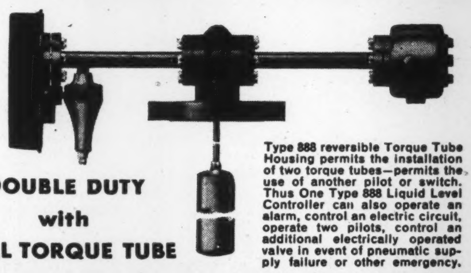
TYPE 888

Any level control is accurate when first set—but BS&B's new Climax Type 888 Liquid Level Controls are **consistently** accurate! Whether the liquid level range is ¼" or 120"—the CONE PIVOT suspension point of the new Climax 888 is friction free—largely self-compensating for misalignment—does away with the sticking action of outboard bearings or the climbing of knife edges.

To inspect or replace the cone point—external positioning makes the job a matter of minutes.

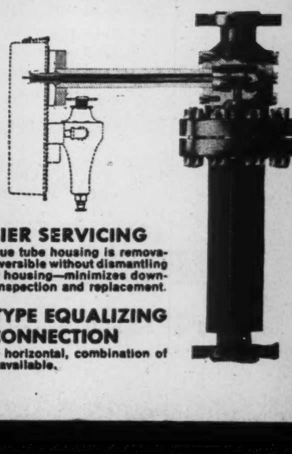
TYPE 888 TORQUE TUBE is stronger, heavier and made of INCONEL—the material found most corrosion resistant under torsion stresses. (Other alloys available in stock for special conditions.) The torque tube shaft is rigidly centered by a friction-free ball bearing.

HEAVY TORQUE TUBE helps provide longer life—permits the employment of heavier displacement elements with high safety factor and wider gravity range application.



DOUBLE DUTY with DUAL TORQUE TUBE

Type 888 reversible Torque Tube Housing permits the installation of two torque tubes—permits the use of another pilot or switch. Thus One Type 888 Liquid Level Controller can also operate an alarm, control an electric circuit, operate two pilots, control an additional electrically operated valve in event of pneumatic supply failure or other emergency.



EASIER SERVICING
—the torque tube housing is removable and reversible without dismantling controller housing—minimizes downtime for inspection and replacement.

ANY TYPE EQUALIZING CONNECTION
—vertical, horizontal, combination of both, are available.

CLIMAX
BS&B
CONTROLS

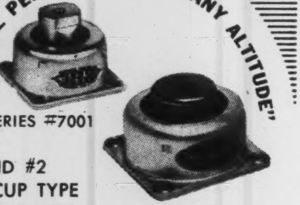
WRITE TODAY FOR NEW, COMPLETE CLIMAX SECTION [illegible] CATALOG (TYPE 888 LIQUID LEVEL CONTROLLER)

BLACK, SIVALLS & BRYSON, INC.
CLIMAX CONTROLS DIVISION, DEPT. 61-[illegible]
7500 E. 12TH, KANSAS CITY 3, MO.

NEW All-Metal...
UNIT MOUNTS
AND
UNIT MOUNTING
BASES

MET-L-FLEX

"SEA LEVEL PERFORMANCE AT ANY ALTITUDE"


SERIES #7001

#1 AND #2
SIZE CUP TYPE
UNIT MOUNTS

SERIES #7002

VIBRATION ISOLATION AND SHOCK PROTECTION FOR AIRBORNE EQUIPMENT

Minimum weight — Maximum structural strength — Complies with all applicable Government specifications — High inherent damping provides stability with shock and over-load capacity — Wide environmental tolerance — Optimum performance under all service conditions. #7001 in 5 load ranges ½ to 10 lbs. — #7002 in 5 load ranges 2½ to 40 lbs.

SERIES #878

Two #7001 Unit Mounts assembled on common tie plate with bonding jumper — Simplifies mounting and reduces assembly time — Load ranges from 1 to 20 lbs.

SERIES #892

Complete Mounting Bases are available incorporating #7001 or #7002 Unit Mounts. Write for engineering data.

ROBINSON AVIATION INC.
TETERBORO, NEW JERSEY
Vibration Control Engineers

mounted on stand, and high-stability 4-tube amplifier with 2-scale meter. Scales read 0.0005 and 0.00005 in. or 0.0001 and 0.00001 in. per division, either side of zero.—*Graham-Mintel Instrument Co., 735 Carnegie Ave., Cleveland 15, Ohio.*

Mention No. 1207 when filling out card.

Electronic Stethoscope

New "Elec-Detec" electronic stethoscope has metal probe which transmits impulses to headphones. Localizes source of noise and helps diagnose trouble. Locates friction noises in bearings, pistons, valves, etc. Furnished complete with high-impedance headphones, batteries, and case.—*Anco Instrument Div., 4254 W. Arthington St., Chicago 24, Ill.*

Mention No. 1208 when filling out card.

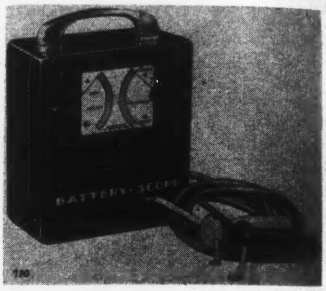
Power Analyzer

New "Model 1782" analyzer measures volts (0-150-300-600), amperes (0-1.5-5-15-50-150-300), watts (0-300 min. to 240,000), reactive KVA (translated by monograph to power factor), and phase rotation of 3-, 2-, and single-phase circuits. Frequency is 25 to 133 cps; accuracy of ammeter and voltmeter is 1 percent, wattmeter 2 percent. Tap-changer switch makes it possible to change current ranges under load. Weight is 34-lbs.—*Niagara Electrical Instrument Co., 559 Ellicott St., Buffalo 3, N. Y.*

Mention No. 1209 when filling out card.

Battery Tester

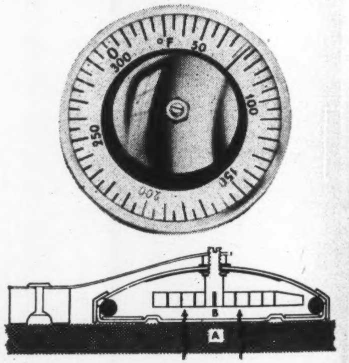
New "C&C Battery-Scope" is open-circuit battery tester. Employs principle of cell-balance analysis. Three individual cells of battery are balanced against each other in sensitive bridge circuit of tubeless magnetic amplifiers. Degree of unbalance is registered on meter. Even completely discharged battery can be tested. State of charge is also indicated on second scale, thus eliminating need for hydrometer. Standard model is "type X-10." Deluxe model "type X-20" includes system for testing battery cables and starter switches.—*McColpin-Christie Corp., Ltd., 3410 W. 67th St., Los Angeles 43, Calif.*



Mention No. 1210 when filling out card.

Surface-temperature Thermometer

New "Model 310" surface-temperature thermometer may be affixed to any flat surface by silicone grease or to any ferrous surface by small magnetic clamp. Thermometer indicates temperature from back of instrument only as highly reflective evaporated mirror on dial insures thermal element against external radiation. Range is 0 to 300 deg., calibrated in 2-deg. increments. Diameter is 2 in.; weight is one oz.—*Pacific Transducer Co., 11921 W. Pico Blvd., Los Angeles 64, Calif.*



Mention No. 1211 when filling out card.

Resistance Thermometer

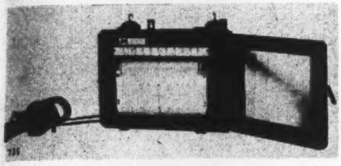
New "Fuse-Din" all-quartz long-stem resistance thermometers are constructed of molybdenum or tungsten wire fused into wall of transparent quartz tube. Internal leads are fine silver for measurements to 900 C. or platinum for higher temperatures. Alumel can be used to 1100 C. Overall length is

9 in. Sensitive tip is 2.5 in. O.D. is ¼ in. Ice-point resistance is 150 ohms. Resistance increment is 0.7 ohm per deg. C. Speed of response is high and can be increased by use of sensitive tip of 0.140 in. O.D.—*Weiller Instruments Corp.*, 95 *Broad St., New York* 4, *N. Y.*

Mention No. 1213 when filling out card.

Current Recorder

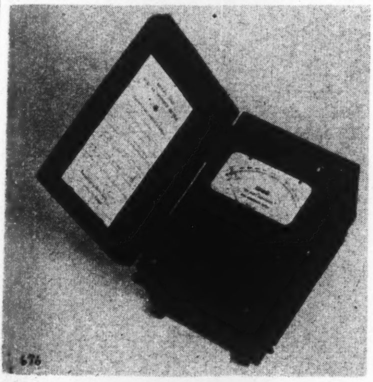
New "TAG Recording Ammeter" uses "Clamp-Ammeter Unit Model 633, Type AIR-A2R" for recording alternating current without breaking circuit. Rectifier network in instrument rectifies induced a.c. into d.c. supplied to recording ammeter. Clamping jaws withstand breakdown test of 5,000 v. a.c. and can accommodate conductors two inches in diameter. Overall accuracy is 3 percent. Recorder can be supplied as 12-point recording ammeter for permanent installation on four-wire three-phase system.—*Tagliabue Instruments Div., Weston Electrical Instrument Corp.*, 614 *Frelinghuysen Ave., Newark, N. J.*



Mention No. 1214 when filling out card.

Soil-resistivity Meter

New "Model 243-A Vibroground" is direct-reading meter for measurement of soil resistivities from 0 to 30,000 ohms per cubic centimeter. Weight (with batteries) is only 9 lbs.; size is 9 x 6 x 6½ in. Meter glass is shatterproof. Power provided by eight No. 2 flashlight batteries. Probe has comfortable handle and replaceable tip.—*Associated Research, Inc.*, 3766 *W. Belmont Ave., Chicago* 18, *Ill.*



Mention No. 1215 when filling out card.

Subminiature Meter

New "Emico Subminiature Meter" is said to be smallest d-c. milliammeter ever developed, measuring 41/64 inch in diameter. Meter in steel case can be mounted in 9/16 diameter hole. It is 13/16 in. long and requires 3/4-in.

meet the new member of the family

model 21-401 mass spectrometer

an analytical and isotope-ratio mass spectrometer combined

CONSOLIDATED's new Model 21-401 Mass Spectrometer is a compact, medium-priced instrument, ideal for those laboratories having only moderate analytical loads. Highly versatile, it provides not only quantitative analyses of gaseous or light-liquid mixtures as automatically recorded mass spectra, but *also* precise *recorded* ratios of stable gaseous isotopes. Like the widely used Model 21-103, it is exceptionally accurate and incorporates many automatic, time-saving features. For the multitude of industrial and scientific applications not requiring extremes of mass range, sensitivity, and operating speed, the Model 21-401 is of maximum value. Further information is contained in Bulletin CEC-1821-X1.

The widely used Model 21-103 Mass Spectrometer for broad applications - analytical and research.

Model 21-201 Isotope-Ratio Mass Spectrometer - specifically for measuring ratios of stable isotopes in gases.

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DUNCAN & BAYLEY, INC.
POSITION SERVO ACTUATORS

ZERO BACKLASH for LIFE...

independent of extreme precision

Zero backlash is achieved in Duncan & Bayley Position Servo Actuators by virtue of design rather than high cost fabrication. No springs, no close tolerances on gear centers, no split gears are employed. Reduced shock loading eliminates excessive tooth wear. In addition, Duncan & Bayley Position Servo Actuators incorporate these PLUS advantages.

- Function independent of ambient temperature beyond most airborne requirements.
- Eliminates motor armature inertia; effective torque to inertia ratio improvement 20:1. Torque is independent of speed.
- Torque repeatable for equal conditions within ±1% independent of speed.
- Improved amplification factor, output 80 watts for 40 MA (3 watt) control.
- Continuous heat dissipation 40% of maximum rating.
- Life consistent with typical industrial machinery.

Applications for Duncan & Bayley Position Servo Actuators

Radar antennae transmissions
Autopilots
Computer Drives
Valve Servos
Tension Controls

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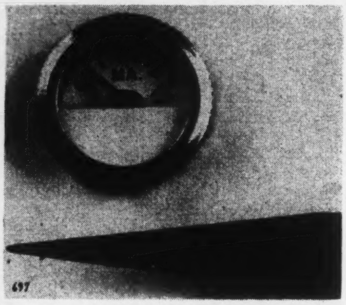
NEW INSTRUMENTS

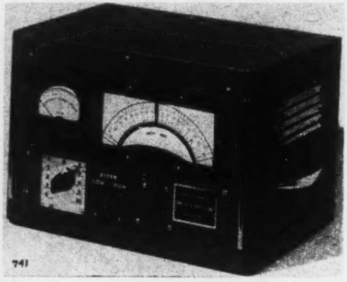


clearance in back of panel. Ranges are from 0-1 to 0-25 d-c. ma. Accuracy is 5 percent.—*The Electro-Mechanical Instrument Co.*, 812 *Chestnut St., Perkasie, Penna.*

Mention No. 1216 when filling out card.

Dynamometer

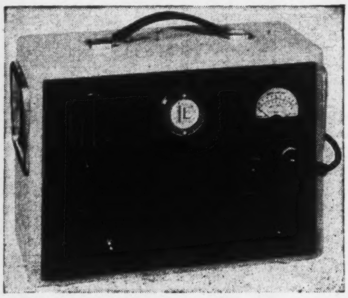
New dynamometer for fractional-hp. (to 0.40 hp.) applications gives simultaneous reading for torque and rotational speed. Comprises standard "Duncan & Bayley PM 2" hysteresis brake mounted in low-friction ball bearings to which counterweight is attached. Torque is measured directly. Speed is measured by salient pole generation. Features include: Two-position switch for dual-range tachometer, easy recalibration, salient pole tach generator absorbs insignificant power at speeds in excess of 500 rpm. and accurate readings of low torque. Operates on 115-v. a.c. or d.c. power.—*Duncan & Bayley*, 785 *Hertel Ave., Buffalo* 7, *N. Y.*



Mention No. 1217 when filling out card.

Insulation Tester

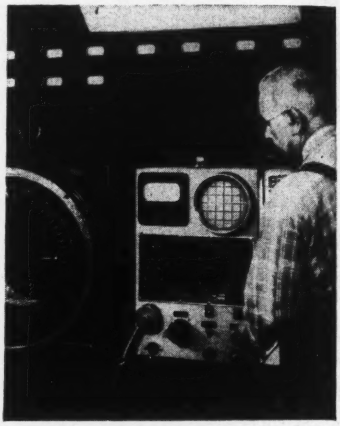
New "English Electric" British-made electronic insulation tester measures insulation resistance at any d-c. potential from 500 to 10,000 v. d.c. Also provides aural indication of a-c. leakage or ionization current through test specimen. Indicates both applied potential (E) and current leakage (I) by switch selection. Resistance is E/I. Three ranges cover 100 to 250,000 megohms. Chart is supplied for resistance calculation. Power is 110 or 220 v., 60 cycle; weight is 23 lbs. Non-lethal short-circuit output is 0.5 ma.—*Herman H. Sticht Co., Inc.*, 27 *Park Place, New York* 7, *N. Y.*



Mention No. 1218 when filling out card.

Surge Comparison Tester

New industrial electronic surge comparison tester locates insulation faults and winding dissymmetries in motors, a-c. and d-c. generators, transformers, and coils. Available in either mobile or portable models. Simultaneously tests turn-to-turn, phase-to-phase, and coil-to-ground insulation with potentials high enough to simulate power-circuit transient stresses. Results are obtained by single scope observation. Non-destructive testing is assured even on fractional horsepower motors and generators.—*Westinghouse Electric Corp.*, *P. O. Box* 2099, *Pittsburgh* 30, *Penna.*



Mention No. 1219 when filling out card.

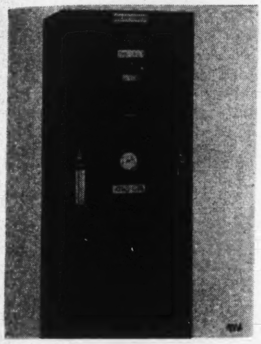
Pulse Generator

New "Model D-2 Calibrator" has 17 pulse rates available at output. Coincidence circuits eliminate phase lags between outputs. Can be used for calibration of synchroscopes, as secondary frequency standard, etc. Simultaneous outputs have followed pulse spacings: 10, 100, 1,000, 10,000, and 100,000 microseconds. Selection of pulse spacings from 20 to 200,000 microseconds is available; also pulses having pulse width which is function of repetition period.—*Rutherford Electronics Co.*, 3707 *S. Robertson Blvd., Culver City, Calif.*

Mention No. 1220 when filling out card.

Atmosphere Generator

New "Type M-5724-S Atmo-Gen" atmosphere generators provide atmospheres for heat-treating operations

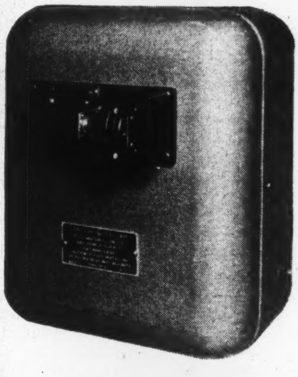


such as clean non-decarburized hardening, dry cyaniding or carbonitriding, carburizing (carrier gas), copper and silver brazing, etc. Delivers 150 cubic feet of atmosphere per hour. Consists of ammonia cracker housed in steel cabinet. Includes an electric-tube furnace with temperature control, catalyst filled alloy retort, and flow-regulation accessories.—*Hevi Duty Electric Co., Milwaukee* 1, *Wis.*

Mention No. 1221 when filling out card.

Step-motor Counter

New step-motor impulse counter provides 100-percent accuracy up to 60 counts per second. Covers counting ranges above those possible with electromechanical counters and below those



in which scalers are used. Consists of step motor with resetting-type register, and a power supply enclosed in steel case. Enclosure contains electronic switch and high-voltage supply for phototube preamplifier. Can be used at rates in excess of 100 counts per second. Weight is 12 lbs. Operates on 115-v. 60-cycle power.—*Special Products Div., General Electric Co., Schenectady* 5, *N. Y.*

Mention No. 1222 when filling out card.

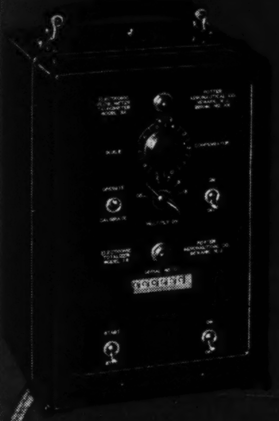
Exposure Meter

New "Mascot PR-30" direct-reading exposure meter is designed primarily for use with color film. Rotating scale with calibrations for 4 film-speed index numbers (5, 10, 16, 50 A.S.A.) eliminates conversions and calculations.

New POTTER Electronic
FLOWMETER and TACHOMETER

Improved design eliminates

★ BEARING MAINTENANCE
★ HIGH PRESSURE DROP
★ BEARING FRICTION



The improved Potter Electronic Flowmeter (patent pending) combines extreme accuracy with freedom from maintenance. This new design eliminates thrust bearings, high pressure drop, and bearing maintenance.

The Potter Flowmeter comprises a flow sensing unit having a hydraulically balanced rotor and magnet rotating within a compact non-magnetic housing, and an external pickup coil connected to an electronic integrator or totalizer, or both.

ACCURATE within ±½%

Since the novel, high-efficiency rotor spins in a freely balanced position within a venturi, its blades operate with practically no slippage. Fluid viscosity, pressure, temperature, and specific gravity only slightly affect the volumetric flow rate. Accuracy is maintained within ±½%. Electric impulses from the rotor are conducted to a combination electronic integrator and totalizer. Rate of flow can be read or recorded either directly or remotely, and total flow is indicated on a resettable magnetic Veeder-Root counter.

We will gladly help you solve your flow measuring problems.

APPLICATIONS

Potter Flowmeters accurately measure flow. Especially suitable for highly corrosive liquids, gases, acids and liquid oxygen.

SEND FOR NEW BULLETIN 1050

which gives full information, pressure drop chart, ranges, sizes, and operational data.

POTTER AERONAUTICAL CO. [illegible]

Century

RECORDING
GALVANOMETERS

The Century Model 210 Galvanometer has been designed and tested for the utmost in performance under any conditions. The unique small tubular type construction permits their installation in practically any type or make of photographic recording oscillographs. These galvanometers are offered at low cost over a wide range of frequencies and sensitivities to satisfy most recording requirements. For additional information, write for our Catalog No. CGC 206.

Manufactured under Century Pat. 2439576, also licensed by Kannestine Laboratories Patent 2149442.

Century

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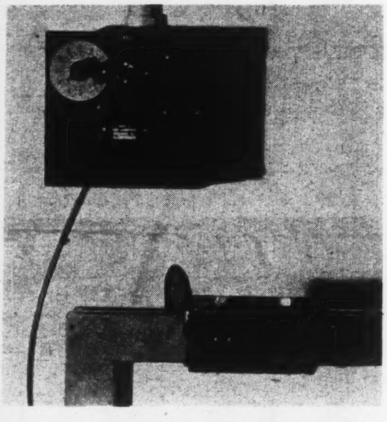
World's Largest Manufacturer of Geophysical and Special Galvanometers

Pointer reading is camera setting. Weight is 2.5 oz. Selenium-barrier photovoltaic cell has sensitivity from 9 candles/sq. ft. to brightest sunlight. —*Meter and Instrument Dep't, General Electric Co., Schenectady 5, N. Y.*

Mention No. 1223 when filling out card.

Exposure Controller

New "Type-EC Model-1 Exposure Controller" produces photographic prints of constant exposure regardless of negative density, light-source intensity, or exposure time. Light falling on film during exposure is integrated electronically. When preset total-light point is reached, exposure light is cut off.—*Shepard Laboratories, 430 Morris Ave., Summit, N. J.*



Mention No. 1224 when filling out card.

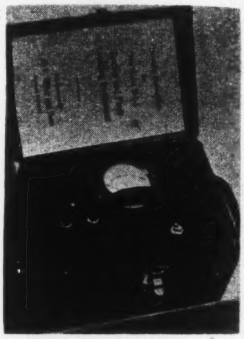
Carrier Telephone System

New "Type 32E" carrier system provides three or four high-quality telephone voice channels to long-haul toll lines. Eight-foot rack contains modulator-demodulator panels for first three channels, pilot regulator, and subordinate equipment. Space is available on rear for fourth channel sub-assemblies. Utilizes frequency spectrum from 3.3 to 35 kc. for four channels, but can be operated with three channels on lines equipped with carrier systems above 30 kc.—*Lenkurt Electric Co., San Carlos, Calif.*

Mention No. 1225 when filling out card.

Fault Locator

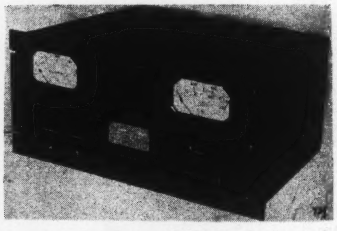
New instrument which determines exact location of faults or crosses by direct meter reading is portable (9 lbs.) and little affected by high-resistance crosses or faults or stray or parisitic currents invading ground connections. Built-in ohmmeter measures resistance from 0 to 2 megohms. Detects location of a fault or cross on any conductor which has resistance of at least 0.1 ohm for each 50,000 ohms of resistance of cross or fault.—*R. F. Miller & Sons, Harvard, Neb.*



Mention No. 1226 when filling out card.

Regulated Power Supply

New "Model 208-A" power supply provides (1) 0-600 v. d.c. at 200 ma. with regulation better than 0.5 percent from no load to full load, hum less than 5 mv., and output impedance less than 2 ohms; (2) 0-150 v. d.c. at 5 ma. with regulation within 1 percent at 150 volts; and (3) 6.3 v. a.c. at 10 amp. unregulated. Weight is 47 lbs.—*Electronic Measurements Co., Red Bank, N. J.*



Mention No. 1227 when filling out card.

Line-voltage Regulator

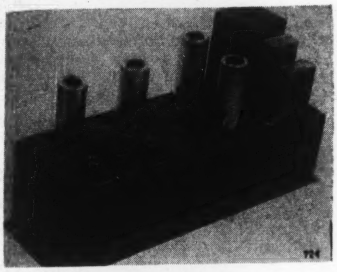
New "Model 1001" a-c. line-voltage regulator, said to be "absolute first in its field," has regulation accuracy of 0.01 percent over load range of 1-1000

va. Input is 95-130 v. a.c. single phase, 55-65 cycles; output voltage is adjustable from 110-120 v. a.c. Contains 3-function output switch for normal regulator functioning, operation with integral semi-fixed resistance in place of potentiometer, and direct load connection with control diode for regulation of voltages other than 115 v. Uses four vacuum tubes and no relays.—*Sorensen & Co., Inc.*, 375 *Fairfield Ave., Stamford, Conn.*

Mention No. 1228 when filling out card.

Servo Amplifiers

New "Type 421-A and 423-A" are universal, 400-cycle servo amplifiers, designed to drive two-phase servo motors requiring 6 and 9 watts per phase respectively. Independent screw-driver control on damping, gain, and carrier phase. Maximum gain, 1000; phase adjustable thru 160 degrees; internal pickup below 2 millivolts. Functions with any carrier-frequency data system.—*Industrial Control Co., Wyandanch L.I., N. Y.*



Mention No. 1229 when filling out card.

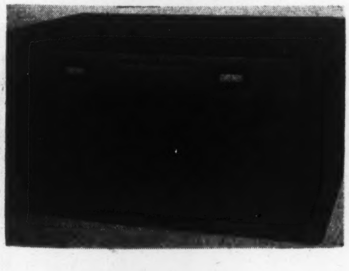
Aircraft Temperature Control

New "Micropulse" aircraft temperature control system has pulse duration that matches system response requirements and actuator speeds for stable control. Controls any standard reversible actuator or actuator-valve combination without mechanical or electrical follow-up and without feedback. Employs no electronic amplifiers or tubes.—*Barber-Colman Co., Aircraft Div., Rockford, Ill.*

Mention No. 1230 when filling out card.

UHF Sweep-Marker Generator

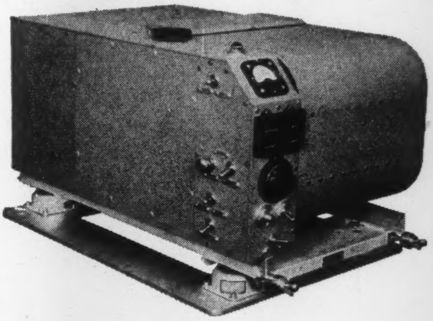
New "WR-40 A UHF Sweep-Marker Generator" incorporates three types of UHF testing facilities—sweep-frequency oscillator, marker oscillator, and crystal calibrator. Frequency range is from 450 to 920 Mc.; sweep width is from 0 to 45 Mc. Uses two newly-de-



Century INDUSTRIAL

RECORDING OSCILLOGRAPH

FOR VIBRATION, TEMPERATURE, STRESS, STRAIN ANALYSIS



MODEL 408 OSCILLOGRAPH

The Century Model 408 recording oscillograph was designed expressly for airborne and mobile operation. As with all Century products, this oscillograph incorporates the utmost in design and workmanship, aloag with improved features, yet it remains simple in its operation and maintenance.

FEATURES:

Size: 20" long, 12½" wide, 8⅞" high.

Weight: 60 pounds.

Number of Recording Channels: 6 to 50.

Detachable daylight loading magazine accommodating a roll of paper or film 8" x 200'.

Friction roller type paper drive by governor controlled electric motor with separate motor for takeup drive.

Paper speeds continuously and instantly variable without changing gears or sprockets.

Separate optical system for viewing before or during recording.

Glow tube timing system photographing .01 second and .1 second lines. .01 second lines instantly removable by toggle switch for slower speeds.

Data numbering at beginning of record.

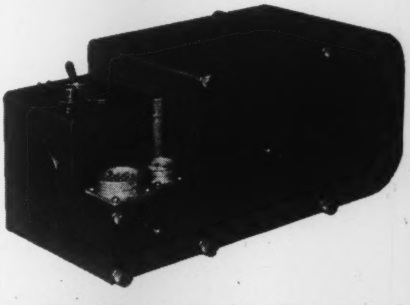
Footage indicator showing amount of paper remaining in magazine.

Automatic record length control.

Trace identification.

Remote control unit.

MODEL 409 OSCILLOGRAPH



The Century Model 409 oscillograph has been designed for recording data where space and weight requirements are limited. This oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:

Size: 5" x 5" x 11".

Weight: 11 pounds.

Cast Aluminum case.

Paper speeds variable ½" to 12" per second.

Detachable daylight loading magazine with a capacity of 3⅝" x 50' paper or film.

2 to 12 individual channels.

Trace identification.

Trace viewing.

For Complete Information Write 1340 North Utica

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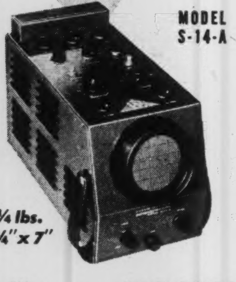

Another Waterman POCKETSCOPE providing the optimum in oscilloscope flexibility for analyses of low-level electrical impulses. Identified by its hi-sensitivity and incredible portability, S-14-A POCKETSCOPE now permits "on-the-spot" control, calibration and investigation of industrial electronic, medical and communications equipment. Direct coupling without peaking, used in the identical vertical and horizontal amplifiers, eliminates undesirable phase shifting. Designed for the engineer and constructed for rough handling, the HI-GAIN POCKETSCOPE serves as an invaluable precision tool for its owner.

Vertical and horizontal channels: 10mv rms/inch, with response within —2DB from DC to 200KC and pulse rise of 1.8μs. Non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude. Repetitive or trigger time base, with linearization from ½cps to 50KC with ± sync. or trigger. Trace expansion. Filter graph screen. Mu metal shield. And a host of other features.

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S-10-B GENERAL	POCKETSCOPE
S-11-A INDUSTRIAL	POCKETSCOPE
S-14-B WIDE BAND	POCKETSCOPE
S-15-A TWIN TUBE	POCKETSCOPE

Also RAKSCOPES, LINEAR AMPLIFIERS, RAYONIC TUBES and other equipment

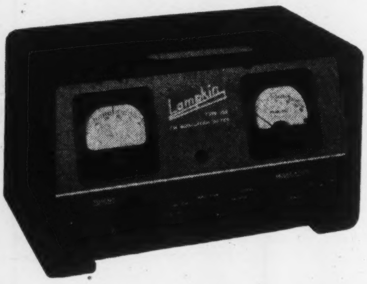
WATERMAN PRODUCTS

veloped "Type 5675" pencil triode tubes designed for UHF operation. Weight is 55 lbs.—*RCA Tube Dept., Camden, N. J.*

Mention No. 1231 when filling out card.

FM Modulation Meter

New "Type 205 FM Modulation Meter" indicates maximum frequency deviation due to modulation of FM transmitters in mobile services, as required by FCC. It is instantly adjustable to any frequency from 30 to 200 Mc. Relative field strengths of different transmitters, or of same transmitter with different adjustments, can be shown. Meter indicates modulation swing only, not center frequency.—*Lampkin Laboratories, Inc., Bradenton, Fla.*



Mention No. 1232 when filling out card.

C-r Tube Reactivator

New C-r tube reactivator weighs only 3 lbs., and operates from 110 v. a.c. Reactivator gives full complex reactivation to tubes in which gases have poisoned cathode, complete with short ageing cycle; increases emission and brightness of tubes.—*Transvision Inc., Dept. DG, New Rochelle, N. Y.*

Mention No. 1233 when filling out card.

Transmission Set

New "Type 12A Transmission Measuring" or "Gain Set" is designed for measurement of voice transmission systems. Source output and receive input are 600-ohm balanced circuits. Oscillator is 1000-cycle low-distortion feedback-type R-C oscillator, buffer, and associated power amplifier. Receive section is high-gain wide-range amplifier whose range is variable from 20 to —50 db. in steps of 10 db. Filters provide four frequency-response curves. Limiter limits peak power to meter.—*The Daven Co., 191 Central Ave., Newark, N. J.*

Mention No. 1234 when filling out card.

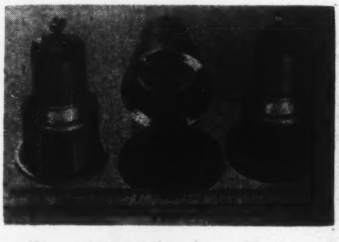
Radiation Monitor

New "Radiation Sentinel Model 1615A" laboratory monitor, has 4-in. meter and switch to select either count rate or geiger-tube voltage. Covers 5 ranges from maximum of 500 to maximum of 50,000 counts per min. full scale. Switch selects 2, 5, or 15 percent statistical accuracy by suitable time constants. Magnetically mounted probe permits thin mica window counter to be mounted on any ferromagnetic object.—*Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago, Ill.*

Mention No. 1235 when filling out card.

End Window Counter

New "Model B1E Geiger-Mueller Counter Tube," which utilizes a fusion-sealed mica end-window, has 1⅛-in. diam. windows supplied in any thickness from 1.6 mg./cm.^{2} up. Features include small overall size, low cost, and one-year guarantee. Uses include laboratory and field operations at any altitude in measurement of strong and weak radiation sources.—*Nuclear Development Laboratory, P. O. Box 7034, Kansas City, Mo.*



Mention No. 1236 when filling out card.

Scintillation Counter

New "SC-la" portable scintillation counter has 25 times gamma efficiency of conventional G-M tube. Includes permanent thallium-activated sodium iodide crystal mounted in removable cap, "RCA 5819" photomultiplier tube with circuitry, and 6-ft. cable to scaler or ratemeter. Weight is 1.5 lbs. Accessories include lead collimator and crystal cap for wide-angle gamma counting.—*Nuclear Research Corp., 2707 Federal St., Philadelphia 46, Penna.*

Mention No. 1237 when filling out card.

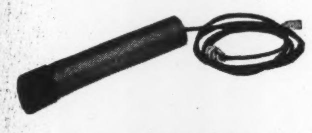
Beta Gages

New "Absorption and Backscatter Beta Gages" for low-cost determination of weight per unit area of sheet materials determine weight changes by small beam of beta rays. In absorption gages, rays emitted from sealed radioactive source pass through sheet to be measured; absorption is measure of thickness if density of material is constant. Backscatter gages are mounted on one side of the sheet only; use same console and recording apparatus as absorption types, but work on slightly different principle.—*Tracerlab, Inc., 130 High St., Boston 10, Mass.*

Mention No. 1238 when filling out card.

Radiation Probe

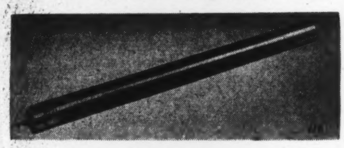
New lightweight radiation probe is scintillation counter comprising phosphor, photomultiplier tube, and two-stage amplifier. Light flashes produced when nuclear particles strike phosphor are converted into electrical pulses by photomultipler. Phosphors for detecting alpha, beta, gamma, and neutron radiations are in caps on end of probe. Weight is 10 lbs.—*Special Products Div., General Electric Co., Schenectady 5, N. Y.*



Mention No. 1239 when filling out card.

Gamma Tube

New "TGC-16" industrial gamma tube, designed for gamma-ray and cosmic-ray counting, can be used for industrial applications such as pipe-line inspection and liquid-level gages. Life is greater than 2×10^8 counts. Starting potential is 870-930 v. Minimum plateau length is 200 v. with slope of 1 percent per 100 v. Fill gas is helium with organic quench. Recovery time is 200 microseconds. Standard sensitive length of 12 in.; available from 5 to 20 in.—*Tracerlab, Inc., 130 High St., Boston 10, Mass.*



Mention No. 1240 when filling out card.

Decontaminating Solution

New "Radiacwash" is general-purpose solution which removes radioactivity from contaminated surfaces. Combines several physical and chemical principles of decontamination. Liquid acts as combination detergent, emulsifier, solvent, ion-extractor, surface wetter, and carrier. Can also be used for general metal-cleansing work.—*Atomlab, Inc., 489 Fifth Ave., New York 17, N. Y.*

Mention No. 1241 when filling out card.

Current Stabilizer

New "Norelco MA Stabilizer" holds tube current constant at any given setting when used in conjunction with company's water-cooled X-ray diffraction equipment. Has three ranges—0.5 to 2 ma., 7 to 25 ma., 25 to 50 ma. Safety circuits protect X-ray tube filament and automatically turns off main dif-

OUTSTANDING CARRIER FREQUENCY STABILITY

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TELEMETERING TRANSMITTER

Bendix-Pacific has developed a new subminiature airborne telemetering transmitter offering outstanding carrier frequency stability under extremes of temperature, vibration and acceleration. This new unit is a crystal-controlled, phase-modulated, VHF transmitter.

The Bendix TXV-11 VHF Telemetering Transmitter, now in production, meets the following specifications:

Temperature Stability: Carrier drift less than ± .02% from —40° C. to +70° C.

Vibration: Maximum noise is less than an equivalent carrier deviation of ± 0.25 kc when subject to a sinusoidal vibration 20 to 300 cps at 10 g in any plane.

Acceleration Error: Negligible to 75 g along 3 major axes.

Power Output: 2 watts (nominal)

Output Impedance: 52 ohms (nominal)

Modulator Input Impedance: 470 K ohms and 60 mmf.

Modulation Index (b): 1.8 at .3 v rms.

Distortion: Less than 1.5% total harmonic distortion for any frequency between 2300 cps and 70 kc at a modulation index of 1.8.

Heater Supply: 6.3 v ± 10% at 1.2 A

Plate Supply: 200 v at 60 ma.

Screen Supply: 150 v at 15 ma.

Size: $2\frac{13}{16} \times 3\frac{5}{8} \times 1\frac{11}{16}$

Weight: 0.9 lb.

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The Xactemp hand-type pyrometer, Model LT-840, is used with needle thermocouples, ribbon thermocouple, surface tip thermocouple, and other specially designed thermocouples and extension arms. These are easily interchangeable and, without adjustments or recalibration of the instrument, quickly ready it for measuring the surface temperature of stationary and revolving rolls and cylinders, flat and irregular surfaces of molds, dies, etc. in rubber and paper making, plastic materials, rubber, wax, oils, greases, and other semifluid materials.

Handy, compact design makes this Xactemp pyrometer ideal for field service, laboratory, and production-line use.

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fraction unit in event of failure in filament circuit. Can be built into existing "Norelco" X-ray diffraction equipment.—*Research & Control Instruments Div., North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.*

Mention No. 1242 when filling out card.

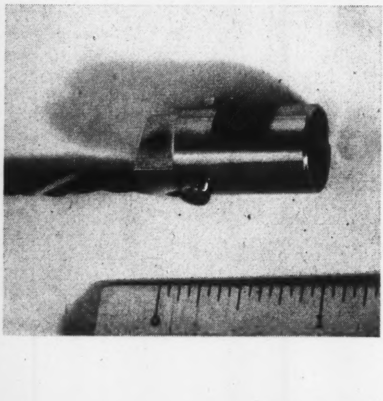
Hydraulic-pneumatic Servo

New "Atcotran Hydraulic-pneumatic Servo System" is method of remotely controlling hydraulic or pneumatic servo cylinder within 0.001 in. System positions control pistons from variables measured by various types of "Atcotran Transmitters." Variables are amplified by servomechanism, which operates a pilot valve in response to electrical signal. Unit controls speed of stroke in either forward or reverse direction and can stop and return stroke with positive repeatability.—*Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Penna.*

Mention No. 1243 when filling out card.

Miniature Magnetic Head

New "CRC Miniature Magnetic Head Model HA 102" provides higher component density in magnetic-memory storage systems. Head has ⅜-in. diam. and 1-in. length. Non-abrasive core will not injure magnetic drum coatings in case of accidental contacts. Operates at frequencies up to 120 kc.; has 13.8 mh. total inductance, and 11 ohms d-c. resistance; is stable over wide temperature ranges; requires only 50-ma. writing current and produces 0.4 volt playback voltage from center tap to one end.—*Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif.*



Mention No. 1244 when filling out card.

Torsion Bar Load Cell

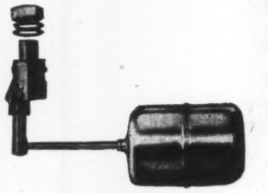
New "Atcotran Torsion Bar Load Cell" changes mechanical force into electrical signal. Consists of a differential transformer and a torsion bar held fast at one end and allowed to rotate on opposite end. Free end connects to force through lever. Armature of transformer also is connected to free end of torsion bar through lever and moves in coil of transformer when force is applied to lever. Generated signal is proportional to armature position off center. Accuracy is ¼ percent of full-load range. Available in ranges from 0-100 pounds to 0-2500 pounds.—*Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Penna.*

Mention No. 1245 when filling out card.

Float Valve

New "No. 18 Series" float-operated valves consist of valve mechanism and float. "No. 118" is variation to protect against back-siphonage. Except for neoprene valve seat, all parts are copper or brass. Opens to full capacity with small float drop, and closes tightly against supply pressures up to 100 lbs. Assembly is held together by single sturdy brass pin. Capacity ranges to 1500 gallons per hour, depending on supply pressure.—*McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.*

No. 18



No. 118

Mention No. 1246 when filling out card.

High-pressure Reducer

New "Ermeto" reducer for high pressure offers high-pressure sealing advantages of tube fitting and can handle reductions ranging from 2 to ⅛ in. without affecting dependable performance.—*Industrial Div., The Weatherhead Co., Cleveland 8, Ohio.*

Mention No. 1247 when filling out card.

Mobile Inspection Unit

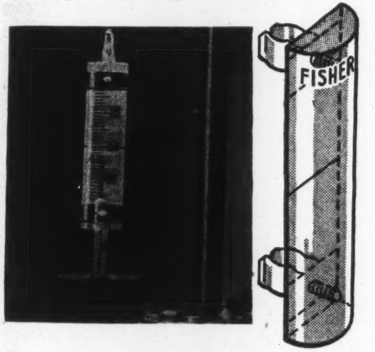
New mobile inspection cabinet contains inspector's tools and measuring instruments. Unit is 37 x 28 x 18 in., constructed of heavy-gage welded steel.

Pressed wood top provides surface for gage inspection. Five drawers are roller mounted and locked. Adjustable light provides illumination.—*The DoALL Co., 254 N. Laurel Ave., Des Plaines, Ill.*

Mention No. 1248 when filling out card.

Thermometer Magnifier

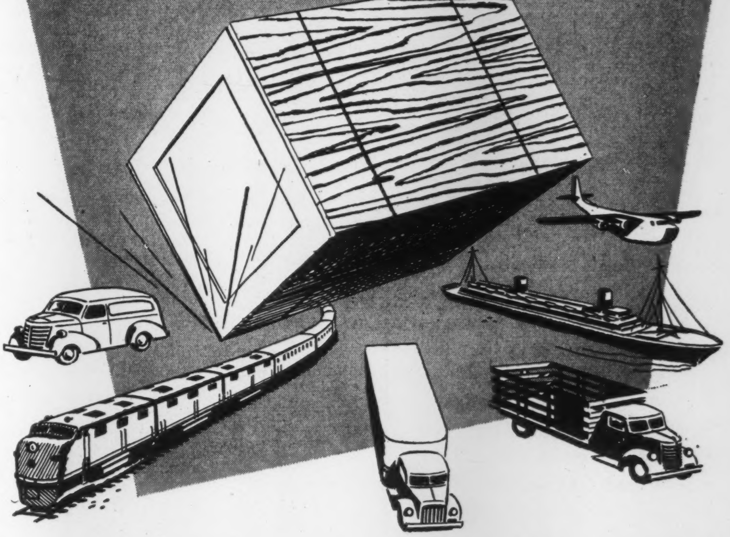
New magnifier with spring clamps is snapped onto any standard thermometer to magnify two-inch section. Operator can take reading from 6 feet. Hairline serves as reference point. Made of polished plastic.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.*



Mention No. 1249 when filling out card.

Bimetal Thermostat

New quick make and break bimetal disk thermostat is for applications in which moisture beads are a problem. "Type MH200" is hermetically sealed



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Lord Shockproof Packing does away with solid bolting, cushion packing, and all other methods heretofore used in the attempt to safeguard the shipment of fragile products, sensitive equipment, and complicated mechanisms.

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From the knowledge and experience gained in over a quarter of a century of specialization in solving shock and vibration problems, Lord has developed flexible rubber mountings to adequately cushion equipment against shock forces from all directions. Lord Shipping Mounts are easily installed in your own shipping cases by your packers. They are accurately designed for correct resiliency and load bearing strength to protect *your* product.

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The LORD representative in your area will recommend the type, number, and placement of Lord Shipping Mounts to safeguard your shipments. Call the nearest Lord Field Office, or write us for full information.

- **Provide positive shock protection.**
- **Permit shipping completely assembled product.**
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- **Eliminate packing errors . . . save time.**
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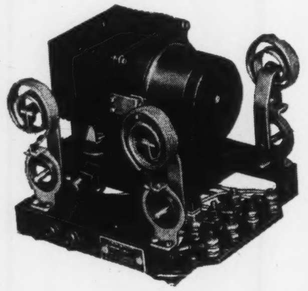
unit in round metal can with neoprene over terminals and leads; "Type MH-100" is enclosed in CR-7 crystal can; "Type MH300" is covered by neoprene enclosure. Silicone rubber can be used for high-temperature applications. Silver contacts are protected from contaminants by hermetic seal. Thermostats are preset at factory. Operating on a.c. of 40 cycles up, units are rated 15 amp. at 115 v. and 10 amp. at 230 v. —*Stevens Mfg. Co., Inc.*, 69 *S. Walnut St., Mansfield, Ohio.*

Mention No. 1250 when filling out card.

Vibration Mount

New center-of-gravity type vibration-isolation mount operates in all attitudes of mounting and has constant characteristics over wide temperature range. Can withstand shock or sustained acceleration of 10 G's. Four phosphor-bronze laminated spiral springs with copper braid sleeves are located at corners of movable base. Silicone-rubber grommets act as stops under severe shock conditions.—*Control Dept., General Electric Co., Schenectady* 5, *N. Y.*



Mention No. 1251 when filling out card.

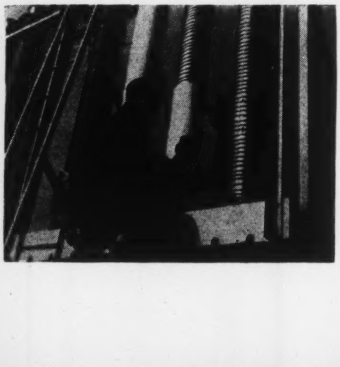
Original Diffraction Gratings

New diffraction gratings can be supplied as follows: Plain or concave, ruled from solid in sizes up to 75 mm. x 120 mm., thickness of glass slab about 15 mm. Number of lines per mm.—200, 333, 400, 500, or 700. Gratings are precision ground and precision ruled.—*National Instrument Co.*, 5005 *Queensbury Ave., Baltimore* 15, *Md.*

Mention No. 1252 when filling out card.

Heating Cable

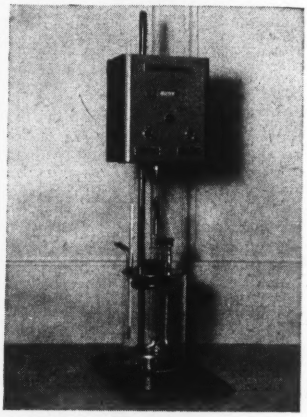
New "Thermwire" is flexible electric heating cable. Consists of heavy-gage nickel-chromium resistor wire with tough abrasion-resistant insulating sheath. Protects machinery, prevents freezing of pipes, etc. Made in two packaged sets—one is 80-ft., 400-watts, 115-v., other is 160-ft., 800-watts, 230-v. Each has 10-ft. cold lead section and plug. Thermostatic control is optional. —*Edwin L. Wiegand Co.*, 7568 *Thomas Blvd., Pittsburgh* 8, *Penna.*



Mention No. 1253 when filling out card.

Gel-time Meter

New gel-time meter measures time required for fluid thermosetting compositions to reach point of rapid viscosity change (incipient gelation) during polymerization by means of rotating spindle suspended from torsional spring. At gel point, viscosity increases suddenly; drag on spindle closes switch which stops timing mechanism and actuates electrical indicator. Meter automatically stops, leaving final reading—to nearest tenth of minute—on dial. Boiling bath is kept at constant temperature. Weight is 20 lbs. Operates on 115-v., 60-cycle, 350-w. power.—*General Electric Co., Special Products Div., Schenectady* 5, *N. Y.*



Mention No. 1254 when filling out card.

Desiccator Holder

New "Desiguard" holds small vacuum desiccators (up to 160 mm., inside dia.) with safety. Holder is comprised of two cylindrical portions which enclose glass object. Lower half has solid surface to hold any spilled liquid; upper part is perforated to relieve any pressure. Opening in top permits desiccator neck and stopcock to protrude. Holder is made of aluminum and is provided with handles.—*Fisher Scientific Co.*, 717 *Forbes St., Pittsburgh* 19, *Penna.*

FISHER JR. DESIGUARD
FISHER SCIENTIFIC CO.

Mention No. 1255 when filling out card.

Viscosimeter Stand

New "Helipath" stand, for use with "Brookfield Synchro-Lectric Viscometer," is fitted with bar-type spindle. Makes consistency measurements in relative centipoise values of materials such as grease, putty, or wax. As spindle is rotated, stand lowers it through test material. Path traced by spindle's crosspiece is helix. Torque required to rotate spindle is registered on dial and converted to centipoise.—*Brookfield Engineering Laboratories, Inc., Porter St., Stoughton, Mass.*

Mention No. 1256 when filling out card.

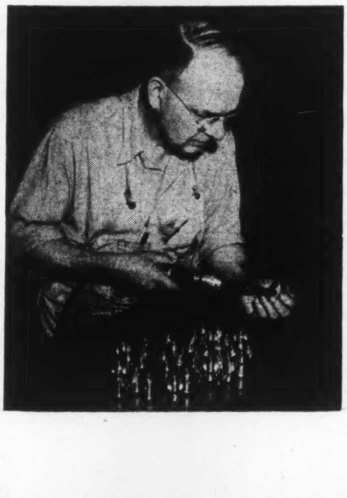
Viscosity Bath

New "Kinematic Viscosity Bath" is unitized constant-temperature bath for use with capillary viscosimeters. New turbine-type stirrer agitates liquid medium without surface turbulence to mar observations. New holder permits free insertion of tube in chuck-like grip without danger of breaking viscosimeter or injuring operator. Fluorescent light in base illuminates bath and viscosimeters.—*Emil Greiner Co., 20 N. Moore St., New York 13, N. Y.*

Mention No. 1257 when filling out card.

Thread-gaging Tool

New "No. 13D-2" air-powered thread-gaging tool for inspection of threads in tapped holes is used with standard taper-lock plug gages. Consists of air motor, friction clutch, and gage adapter. "Press" causes motor to screw "go" gage into hole; "pull" causes reverse



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MATIC
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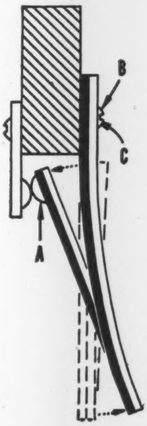
C

ITS BIMETAL SWITCH IS AUTOMATIC

The Tune-O-Matic, Manufactured by Electro-Voice, Incorporated, is an electronic device which automatically amplifies your TV signal. It improves reception in low signal fringe locations and in prime service where an indoor antenna is used. Chace Thermostatic Bimetal plays a vital part, providing a reliable and completely automatic switch which operates in any position, with long life and freedom from buzzing. As the Tune-O-Matic is installed out of sight, often upside down in the cabinet, dependability is mandatory, and the switch must operate without being affected by gravity.



The Tune-O-Matic is plugged into the 105-120 AC outlet and the receiver cord into the booster. Note that the thermostatic bimetal element is generally T-shaped, and that the free upper end of the inner part of the stem at "A" carries the moving contact to the booster circuit. When the set is turned on, the current passes from the lead-in connection at "B" around the narrow outer part of the stem to "C" and so into the receiver receptacle. The resistance of the thermostatic bimetal generates heat under this load, causing it to deflect away from the high resistivity side of the bimetal. Hence, point "A," normally in approximate position shown by dotted lines, deflects down, closing the contacts and completing the circuit to the booster in 2 or 3 seconds. When the set is turned off, the bimetal cools and returns to its original position, breaking the circuit automatically.

Electro-Voice consulted Chace Applications Engineers, specified one of the 29 types available and fabricate from strip. Chace also furnishes random lengths and fabricates and assembles complete elements to customer specifications. Our engineers are ready to assist you in designing your own actuating device and our 64-page reference on thermostatic bimetal is yours for the asking.

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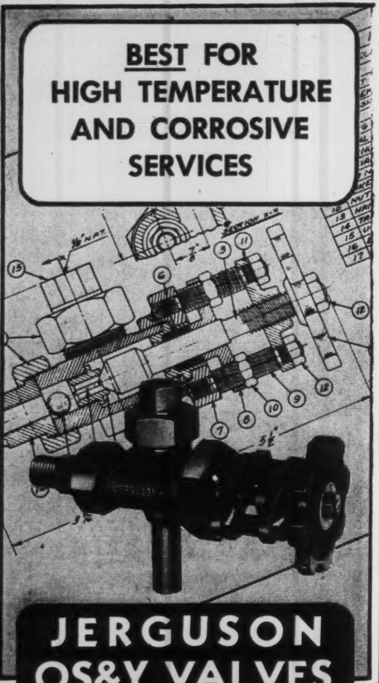
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action, backing gage out. Clutch permits gage to stop (for defective threads) without stalling motor. Clutch friction is adjustable. Weight is 34 oz. —*Keller Tool Co., Grand Haven, Mich.*

Mention No. 1258 when filling out card.

Remote Pipette Control

New "NRD Model RC-1" remote pipette control grasps pipette and snugly places lip in receptor, which is tapered and lined with soft synthetic rubber for air-tight accommodation. Handle contains built-in hypodermic syringe for pipetting operation. Can be used with pipettes covering wide range of volumes of radioactive solutions. Weight is ⅞ lb. Length is 23 in.—*Atomlab, Inc.,* 489 *Fifth Ave., New York* 17, *N. Y.*

Mention No. 1259 when filling out card.

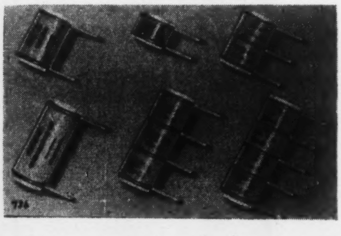
Resistance Thermometer Elements

New "Types BN-3 and BN-4 Stikon" resistance thermometer elements are Bakelite-bonded counterparts of company's "Types PN-1 and PN-2" elements, except that new elements have better stability, longer life, and high operating temperature range. Attached by means of Bakelite cement, elements have fast response. Suited for service from minus 100 F. to plus 300 F.—*Ruge-deForest Inc.,* 84 *Massachusetts Ave., Cambridge* 39, *Mass.*

Mention No. 1260 when filling out card.

Resistors

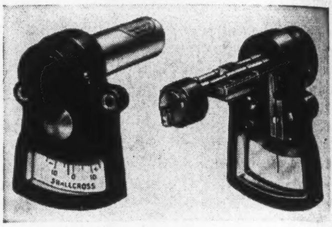
New "BW" resistors with soldered lugs range from single-section chapron-wound to 4-section resistor and multi-pi winding. Resistance values: 1 ohm to 1 meg. Wattage rating: ¼ to 1 watt. Available in variety of resistance-wire alloys and impregnation treatments.—*Cinema Engineering Co., Burbank, Calif.*



Mention No. 1261 when filling out card.

Galvanometer

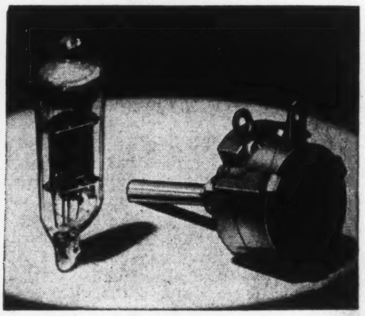
New "Type 1951" d-c. galvanometer system features simplicity and economy. Coil and mechanism are mounted on sturdy rod supports and protected by removable aluminum cover 23/32 inch in dia. Available in 4 types having sensitivities per mm. division of 4, 2, 1, and 0.5 ma. Employs rugged taut-suspension moving-coil principle. Scale is calibrated in 15 div. of 1 mm. either side of center.—*Shallcross Mfg. Co., Collingdale, Penna.*



Mention No. 1262 when filling out card.

Sub-miniature Control

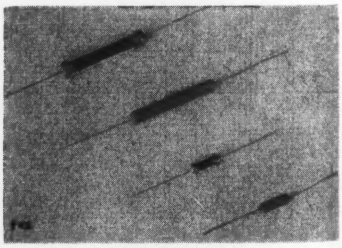
New "Series 48A" improved subminiature potentiometer-rheostat has ⅝-in. dia. Available as single or dual unit. Body depth of single unit is 7/16 in.; double unit 53/64 in. Linear ranges are from 1000 ohms to 5 megohms; tapered resistances from 5000 ohms to 2.5 megohms.—*Clarostat Mfg. Co., Inc., Dover, N. H.*



Mention No. 1263 when filling out card.

Deposited-carbon Resistors

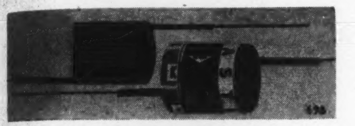
New "Carb-ohm" deposited-carbon resistors are available hermetically sealed in glass or clad in humidity impervious casing. Wattage ratings range from ⅓ to 2 watts with a resistance range of 20 ohms to 200 megohms.—*Phaostron Co.,* 151 *Pasadena Ave., S. Pasadena, Calif.*



Mention No. 1264 when filling out card.

Molded-in Selenium Rectifiers

New "Plastisel" line of miniature selenium rectifiers are molded-in like tubular capacitors. Outer case is spiral-wound phenolic tubing filled with wax which is rock hard at 100 deg. C. Available in ratings up to 200 ma. d.c.—*Electronic Devices, Inc., Precision Rectifier Div., 429-12th St., Brooklyn, N.Y.*



Mention No. 1265 when filling out card.

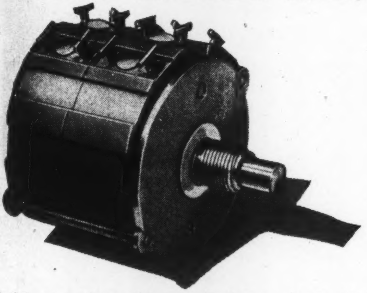
Shielded Leads

New "Type-S Klipzon" shielded leads with proportioned air and polyethylene dielectric have low capacitance and losses at u-h-f. frequencies. Supplied in three-foot lengths with outside diameter of 9/32 in. and maximum capacity of 25 uuf. Black and red "Mini-Prod" connectors are supplied.—*United Technical Laboratories, Morristown, N. J.*

Mention No. 1266 when filling out card.

Multiple Pot-Rheostats

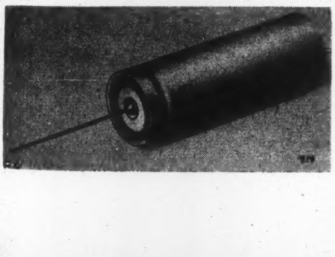
New "Series 42A" potentiometer is encased in mineral-filled bakelite housing designed to lock together with similar units to form tandem assembly held together by end-plates and tie rods. Common shaft slips through all sections. Resistance range is 100 to 100,000 ohms for linear windings; tapered windings are available. Linear controls are rated at 3 watts.—*Clarostat Mfg. Co., Inc., Dover, N. H.*



Mention No. 1267 when filling out card.

Capacitor Seal

New line of "Chemelec" hermetic seals for capacitor can sizes from 0.377 to 0.962 inches is recommended for severe service conditions. Utilizes exclusive (pat. pend.) fused hermetic seal between Teflon and metal. Capacitor seals have no acute strain point and are



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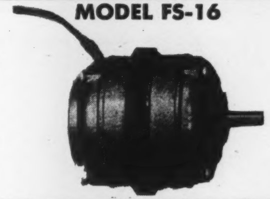
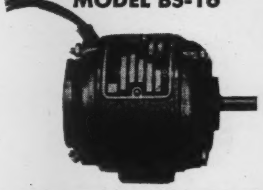
MODEL FS-16



Tachometer generator, 2-phase, 2-pole, 25v @ 1800 rpm per phase. Size 2½" x 2½" flange mounted.

MODEL BS-16

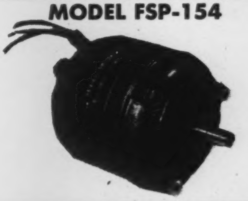


Identical with Model FS-16, but is base mounted.

MODEL FBS-258

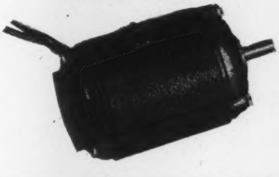
Tachometer generator, 2-phase, 2-pole, 54v @ 1800 rpm per phase. Flange or base mounted; size 2½" x 3⅜".

MODEL FSP-154



Sine-wave generator, 2-phase, 2-pole, 9v @ 1800 rpm per phase. Harmonic content less than ¾%. Face mounted; size 2¼" x 2½".

MODEL FBSP-464



Sine-wave generator, 2-phase, 2-pole, 18v @ 1800 rpm per phase. Harmonic content less than ¾%, size 2¼" x 3⅜".

Multi-pole machines can be wound for one, two, or three-phase. Standard units (except sine-wave generators) contain approximately 5% harmonics. All standard units designed for up to 5000 rpm. Units to 10000 rpm can be furnished on special order. Output of all units linear with speed. Complete drawings and specifications available. When inquiring, a detailed description of your problem or intended use will assist us in sending the proper information promptly.

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Mention No. 1268 when filling out card.

Limit-switch Actuators

New actuators are for "Type ML Micro-Limit" line of heavy-duty precision limit switches. "Type 1ML1" has adjustable roller arm actuator.

"Type 2ML1" has straight plunger actuator. "Type 5ML1" has roller-plunger actuator adjustable 90 degrees in either direction. Switch ratings are 20 amp., 110, 220, or 460 volts a.c.; ½ amp., 115 v. d.c.; ¼ amp., 230 v. d.c. —*Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

Mention No. 1269 when filling out card.

Sealed Limit Switch

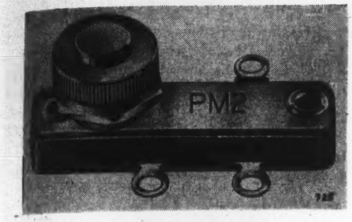
New limit switch is hermetically sealed with inert atmosphere. Tipping diaphragm action (no sliding parts) prevents jamming from ice formation.

DPDT contacts have nearly simultaneous break. SPDT optional. Weight is 0.38 lb.; dimensions are 2-9/16 x 1-9/16 x 1-3/16 in. Switching mechanism can endure over 10,000,000 mechanical cycles.—*The Exhibit Supply Co., 4218 W. Lake St., Chicago, Ill.*

Mention No. 1270 when filling out card.

Miniature Switch

New "Model PM Tyniswitch" is miniature panel-mount switch measuring only 1⅝ x 7/16 x ¾ in. and weighing 17 grams. Rated at 15 amp. at 125 v. a.c. and 7.5 amp. at 250 v. a.c. Move-



ment differential is 0.010 max. Operating force is 7-11 oz. and release force is 2-3 oz. SPST either normally open or normally closed and SPDT.—*Tyniswitch Div., The Sessions Clock Co., Forestville, Conn.*

Mention No. 1271 when filling out card.

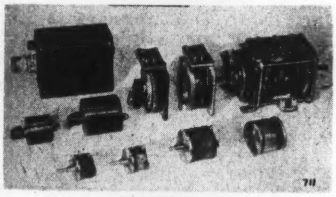
Switch

New "Type A-C-O" switch is maintained-position, alternate-contact switch. First press transfers contacts; second press restores them. SPDT contacts are rated at 20 amp., 125-v. non-inductive a.c. Wide-spaced terminals with barriers reduce wiring problems.—*General Controls Co., Boston 34, Mass.*

Mention No. 1272 when filling out card.

Variable Transformers

New "Powerstat" variable transformers are for operation at 400 cycles and higher. Units are available in a multitude of voltage and current ratings in single and polyphase models.—*The Superior Electric Co., Bristol, Conn.*



Mention No. 1273 when filling out card.

Sealed Relay

New "Diamond-H" 4-pole, double-throw hermetically sealed relays meet requirements of USAF Spec. MIL-R-5757. Tested models withstand up to 64 G's with coil-power consumption of only 1.5 watts, and operate to 80,000 feet altitude. Does not drop out until voltages of 7 or less are reached. Temperature range is more than minus 65 C. to plus 200 C. Transit time is approximately one millisecond. Contact

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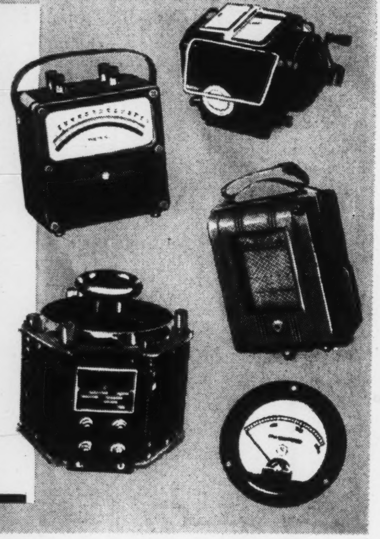

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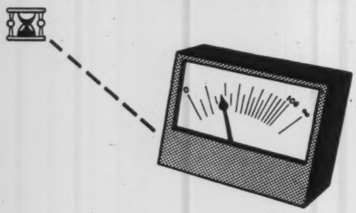

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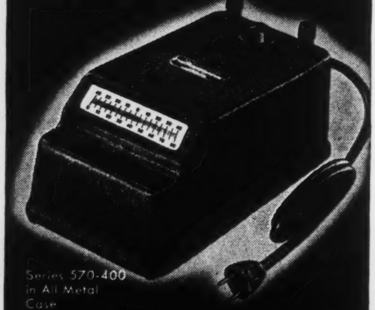

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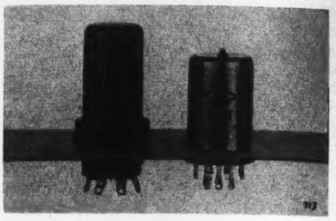
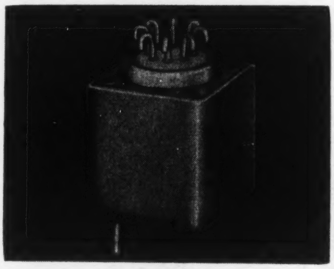


ratings are 2 amp. 28 v., d.c.; 2 a., 115 v., a.c. including 400 cycle. Can be supplied with coil resistances from 10 to 20,000 ohms.—*The Hart Mfg. Co., Hartford, Conn.*

Mention No. 1274 when filling out card.

Sealed Relay

New miniature hermetically sealed relay features 8-terminal hermetically sealed header 0.600 in. O.D. and balanced armature relay sealed in 7/8 x 7/8 x 7/8-in. aluminum can. Can be furnished with dry-air fill or vacuum pumped and pressure filled with dry nitrogen.—*The Hermaseal Co., Inc., Elkhart, Ind.*



Mention No. 1275 when filling out card.

Resin Core Solder

New "Kester 44" highly-active resin flux causes solder to melt, "wet" metal, and flow in one instantaneous action. Resin is non-corrosive and electrically non-conductive. Conforms with Army-Navy-Air Force Spec. MIL-S-6872 (AN-S-62), U.S. Air Force Spec. 41065-B-Method 31, and Federal Spec. QQ-S-571b.—*Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill.*

Mention No. 1276 when filling out card.

X-ray Film Viewer

New iris-diaphragm high-intensity viewer allows study of X-ray film densities from 0.5 to 4.5. Opening can be

steplessly dilated or contracted from 1/4-in. triangle to 5-in. diam. circle. New 100,000 candlepower lamp has average life of 1,000 hours at rated voltage (115 v.). Footswitch leaves hands free. Glass panel shields films from lamp heat.—*General Electric Co., X-Ray Dept., Milwaukee, Wis.*
Mention No. 1277 when filling out card.

Compressed-Fuel Torch

New "Prepo Torch" is instant-flame torch that utilizes replaceable compressed-fuel cartridge. Weight is 1.5 lbs. Can be used in any position. No pumping, priming or pouring necessary. Gives three hours of flame from one container of hydrocarbon fuel. Flame of 2200 deg. F. can flow silver solder. Supplied with two tips—one for bushy flame, and one for pin-point flame.—*Emil Greiner Co., 20 N. Moore St., New York, N. Y.*
Mention No. 1278 when filling out card.

Utility Lamp

New portable fluorescent lamp, useful for bench, machine, microscope, illuminator, etc., produces intense but cool illumination of up to 450 foot candles. Contains two 4-watt fluorescent tubes within 2 by 6 in. drawn shade. Jacknife support bracket contains three adjustable links with swivel joints. Lamps are rated at 7500 hours average life.—*Stocker & Yale, Inc., Marblehead, Mass.*
Mention No. 1279 when filling out card.

High-intensity Light

New mercury arc lamp and water-jacket components have smaller size and lower cost than previous units. Three lamp sizes are available with arc widths of: 1, 1¼, and 1½ mm. Power inputs range between 1 and 2 kw.; brilliances from 40,000 to 90,000 candles

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An extremely sensitive drill press for very small drills down to .002". Drills held in accurate collets to minimize deviation. Spindle run-out less than .0001". Finger tip control enables operator to feel progress of drill.

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will protect base-metal thermocouples, too. Save Chrome and Nickel! Release critical alloys for more important uses.

Wheatstone high-alumina mullite porcelain tubes are recognized as industry's standard.

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FACTORY
FOSTER, KY

Another
PRECISION
PRODUCT

JUST PLAIN
RUGGED
. . . yet an
instrument of
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TO THE *New*
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Hermetically Sealed
INSTRUMENT

The Burlington "Hermetically Sealed" Instrument was designed and is manufactured to conform to JAN specifications for sealed instruments.

- Steel case with heavy copper-cadmium plate and black finish.
- Excellent shielding due to case material and construction.
- Double strength clear glass.
- Black satin onodized aluminum bezel.
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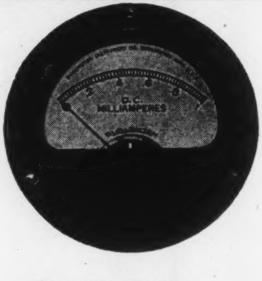
- D'Arsonval per manent magnet type movement for DC applications.
- Designed to enhance panel appearance.
- Available in 1½" square, 2½" and 3½" round case types.
- Guaranteed for one year against workmanship and materials.



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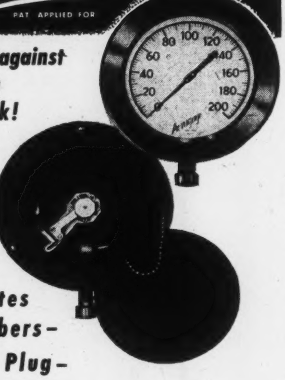
Shockstop!
PAT. APPLIED FOR

Protects against
Pulsation
and Shock!



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The Most Significant Pressure Gage Development in 50 Years.

For the first time, a successful means of eliminating the effect of pulsation and shock on pressure gage mechanisms has been developed which DOES NOT introduce an orifice or restriction in the pressure connection.

It Can't Plug

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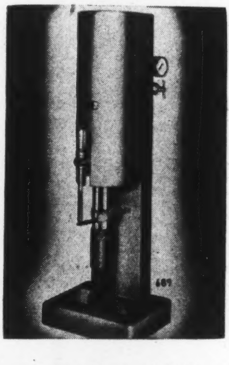
ACRAGAGE CO.
Formerly [illegible] Co.
MILFORD, CONN.

per square centimeter; and light outputs from 65,000 to 130,000 lumens. Operation can be from a-c., d-c., single-flash, or stroboscopic power supplies. All-quartz accessories can be provided where user wishes source of ultraviolet. —*Huggins Laboratories,* (704) *Hamilton Ave., Menlo Park, Calif.*

Mention No. 1280 when filling out card.

Sand Press

New "No. 312" sand press rams test specimens to same degree hardness that foundry rams sand. This enables permeability, strength, and deformation to be known as it exists in mold during green, dry, hot, and retained phases.—*Harry W. Dietert Co.,* 9330 *Roselawn Ave., Detroit 4, Mich.*



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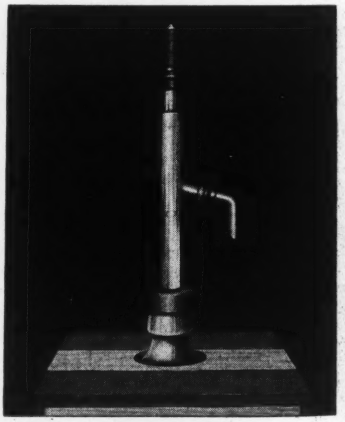
Liquid Dispenser

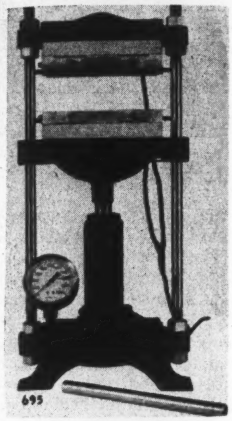
New positive-displacement "Carboy-pump" safely dispenses solvents, acids, alkalies and liquid organic materials from large carboys or any glass, rubber, and metal container. As only material in contact with liquids is Pyrex or Teflon, there is no possibility of contamination from pump. Check valves are Pyrex; Teflon pumping ring is readily replaced in case of wear.—*Laboratory Industries, Inc.,* 4710 *W. North Ave., Chicago 39, Ill.*



Mention No. 1282 when filling out card.

Hydraulic Press

New 3-ton "Econ-O-Press Model 3-8" hydraulic laboratory press has manually operated hydraulic mechanism



which provides total available force of 6,000 pounds. Gage indicates psi. on ram.—*Wabash Metal Products Co., 1569 Morris St., Wabash, Ind.*

Mention No. 1283 when filling out card.

CORRECTIONS
1952 INSTRUMENTS INDEX

The following omissions and misstatements inadvertently occurred in the 1952 INSTRUMENTS INDEX.

In the Product Listing Section, page 42, under "AIR DRYERS, Instruments" should be added: **Kemp Mfg. Co., C. M.**

Kemp Mfg. Co.'s name and address: 405 E. Oliver St., Baltimore 2, Md., also should be added to the Descriptive Directory in the back of the INDEX.

Under the listing "ELECTRONIC EQUIPMENT SUPPLIERS" on page 68, should be added: **Milo Radio & Electronics Corp.**

The Milo listing in the Descriptive Directory is on page 170. Their address is 200 Greenwich St., New York 7, N. Y.

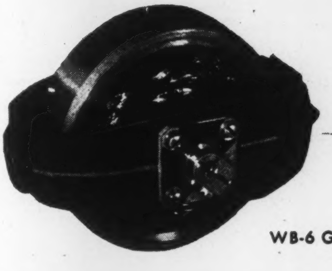
Under the listing "LATHES, INSTRUMENT & ATTACHMENTS" on page 88, should be added: **Derbyshire, Inc., F. W.**

The Derbyshire listing in the Descriptive Directory is on page 163. Their address is 157 High St., Waltham 54, Mass.

The description of products manufactured by **Ballantine Labs., Inc.,** Boonton, N. J., which appears under their name in the Descriptive Directory on page 158, is incorrect and the following should be substituted:

"R.M.S. and peak-reading sensitive electronic voltmeters and ammeters covering a wide range of frequencies."

DOELCAM GYROSCOPES



FOR MILITARY APPLICATION

WB-6 Gyroscope

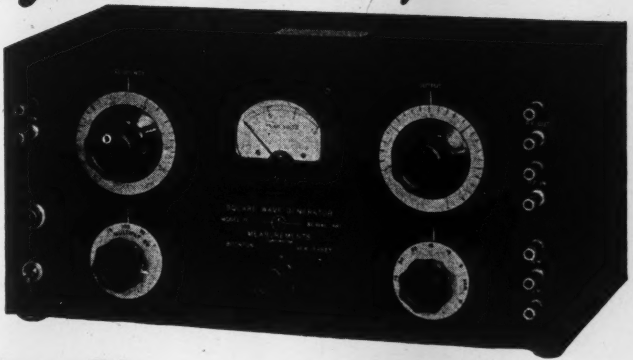
The Gyroscope illustrated has been designed by Doelcam Corporation expressly for high performance military aircraft control applications. The small, accurately balanced rotor of this hysteresis type sychronous motor operates at 12,000 rpm and draws 8.5 watts from a 3 phase, 26 volt, 400 cps power supply. This unit weighs only 11 ounces.

The WB-6 Gyroscope is typical of the small, yet rugged, instruments designed and produced by Doelcam to provide necessary accuracy with a maximum of reliability. The facilities and abilities which have developed and are producing the WB-6 Gyroscope can be applied to your automatic control requirements.

DOELCAM CORPORATION
56 ELMWOOD STREET, NEWTON 58, MASSACHUSETTS
Gyroscopic Flight Test and Control Instrumentation

SYNCHROS • SERVOMECHANISMS • MICROSYNS • ELECTRONIC INVERTERS

Square Wave Generator



MODEL 71

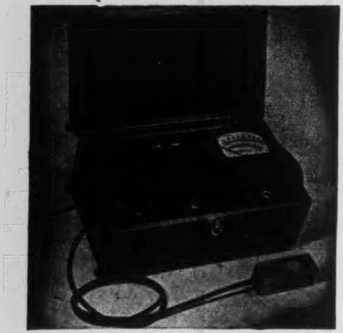
SPECIFICATIONS
FREQUENCY RANGE: 5 to 100,000 cycles.
WAVE SHAPE: Rise time less than 0.2 microseconds with negligible overshoot.
OUTPUT VOLTAGE: Step attenuator giving 75, 50, 25, 15, 10, 5 peak volts fixed and 0 to 2.5 volts continuously variable.
SYNCHRONIZING OUTPUT: 25 volts peak.
R. F. MODULATOR: 5 volts maximum carrier input. Translation gain is approximately unity—Output impedance is 600 ohms.
POWER SUPPLY: 117 volts, 50-60 cycles.
DIMENSIONS: 7" high x 15" wide x 7½" deep, overall.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
L-C-R Bridges
Megohm Meters
Megacycle Meters
Intermodulation Meters
TV & FM Test Equipment

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

S·S·White MOLDED RESISTORS

The "All-Weather" Resistors



ARE USED IN THIS ULTRA SENSITIVE ELECTRONIC PHOTOMETER

In this instrument—designed for measurement of very low light values—S.S.White Resistors serve as the grid resistance in the all-important high-gain D.C. amplifier circuit. The manufacturer, Photovolt Corp., New York, N. Y., reports that the resistors "work very satisfactorily"—which checks with the experience of the many other electronic equipment manufacturers who use S.S.White resistors.

WRITE FOR BULLETIN 4906

It gives essential data about S.S.White Resistors, including construction, characteristics, dimensions, etc. Copy with price list on request.

Photo courtesy of Photovolt Corp., New York, N. Y.

S.S.White
MOLDED
RESISTORS

S.S.WHITE RESISTORS
are of particular interest to all who need resistors with inherent *low noise level* and *good stability* in all climates.
HIGH VALUE RANGE
10 to 10,000,000 MEGOHMS
STANDARD RANGE
1000 OHMS to 9 MEGOHMS

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. L 10 East 40th St.
NEW YORK 16, N. Y.
WESTERN DISTRICT OFFICE: Times Building, Long Beach, Calif.

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Catalog sent upon request
THE MERCOID CORPORATION
4201 BELMONT AVENUE • CHICAGO, ILLINOIS

ELECTRONIC TIMERS

Continued from page 1441

sponds to two timed signals. The upper OA4G tube fires 0.5 second after relay *E* operates; the lower OA4G tube fires 2 seconds after relay *E* operates. If relay *E* is operated, 500 milliseconds later relay *F* operates and closes the external circuit. If relay *E* is not released within 1.5 seconds after relay *F* operates, relay *G* operates and de-energizes relay *F*, which opens the external circuit.

If, on the other hand, relay *E* is released within 1.5 seconds after relay *F* operates, the external circuit remains closed for 2 seconds after relay *E* is reoperated. Relay *G* then operates and opens relay *F*, which in turn opens the external circuit. Then, when relay *E* is released, the timer is reset to its normal state. The value for $(C1) \times (R1 + R2)$ was found from the curves of Fig. 6 for $T = 500$ milliseconds at the firing voltage for an OA4G tube. The value for $(C2)$ $(R3 + R4)$ was determined similarly for $T = 2$ seconds. $R2$ and $R4$ are variable resistors for setting the operate time to a specific value. These variable resistors permit compensation for variations in timer components and supply voltage. Fig. 3 is a timer of this type.

Calendar of Events
1952

Jan. 7-8
American Institute of Electrical Engineers.
Fourth Annual Conference on Electronic Instrumentation and Nucleonics in Medicine.
Commodore Hotel, New York City.

Jan. 28-Feb. 1
Institute of the Aeronautical Sciences.
20th Annual Meeting.
Astor Hotel, New York City.
For information write R. R. Dexter, Sec., 2 East 64th St., New York 21.

Jan. 29-31
American Meteorological Society.
114th National Meeting.
Roosevelt Hotel, New York City.
For information write Kenneth C. Spengler, Ex. Sec., 3 Joy St., Boston 8, Mass.

Feb. 7-8
Instrument Society of America, New York Section.
Fifth Annual Regional Conference, "Power Plant Instrumentation."
For information write Franklin B. Leslie, Sec., 8856 Commonwealth Blvd., Bellerose 6, N. Y.

Mar. 3-6
Institute of Radio Engineers.
National Convention and Exhibit.
Waldorf-Astoria Hotel and Grand Central Palace, New York City.

April 3-4
Instrument Society of America, Pittsburgh Section.
Second Annual Regional Conference, "Instrumentation for the Iron and Steel Industry."
Roosevelt Hotel, Pittsburgh.
For information write W. C. Langerman, Fisher Scientific Co., 711 Forbes St., Pittsburgh 19, Pa.

April 27-May 6
Heavy Industries Fair, Hanover, Germany. This fair includes exhibits of instruments for measurement, inspection, testing and control. For information write Deutsche Messe- und Ausstellungs-A.G., Hannover, Messegelaende, Germany.

May 4-8

Electrochemical Society, Fiftieth Anniversary Meeting, Benjamin Franklin Hotel, Philadelphia. Sessions on Instrumentation have been scheduled. For information write Dr. Henry Linford, Sec., 235 West 102 St., New York 25.

May 5-16

British Industries Fair. Earls Court & Olympia, London includes laboratory and scientific instruments; Castle Bromwich, Birmingham, includes industrial instruments. For information write Board of Trade, Imperial Chemical House, London, S.W.1, England.

May 6-9

Scientific Apparatus Makers Association.
Annual Meeting of all Sections.
Edgewater Beach Hotel, Chicago.

May 7-9

Institute of Radio Engineers.
National Conference on Airborne Electronics.
Biltmore Hotel, Dayton, Ohio.
For information write E. K. Gannett, 1 East 79th St., New York 21.

May 16-17

Southwestern Institute of Radio Engineers.
Conference and Radio Engineering Exhibit.
Rice Hotel, Houston, Texas.

May 18-25

Achema X—Chemical Meeting and Exhibit, Frankfurt, Germany.
At the same time and place the 25th International Congress for Industrial Chemistry will be held. Instruments will be exhibited.
For information write Dr. H. Bretschneider, Deutsche Gesellschaft fuer Chemisches Apparatewisen, Frankfurt am Main 13, P.O. Box 1337, Germany.

May 22-24

American Society for Quality Control, Onondaga Memorial, Syracuse, N. Y. For information write W. R. Weaver, Gen. Chm., 1527 Republic Bldg., Cleveland 1, Ohio.

June 11-13

American Congress on Surveying and Mapping.
Twelfth Annual Meeting and Exhibit.
Shoreham Hotel, Washington, D. C.
For information write Walter S. Dix, Ex. Sec., P. O. Box 470, Benjamin Franklin Station, Washington 4, D. C.

June 23-27

ASTM 50th Anniversary Meeting and 10th Exhibit of Testing Apparatus and Laboratory Supplies, Hotel Statler, New York, N. Y. For information write Robert J. Painter, Asst. Sec., American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Sept. 8-12

Instrument Society of America.
Seventh National Instrument Conference and Exhibit.
Public Auditorium, Cleveland, Ohio.

Sept. 29-Oct. 1

Eighth National Electronics Conference and Exhibition.
Sherman Hotel, Chicago.
For information write Karl Kramer, Ex. Sec., 852 E. 83rd St., Chicago 19.

October

Scientific Apparatus Makers Association.
Midyear Meeting of Recorder-Controller Section.
Seaview Country Club, Absecon, N. J.

Nov. 5-9

Scientific Apparatus Makers Association.
Midyear Meeting of Industrial Instrument, Laboratory Apparatus, Laboratory Equipment, Optical, Aeronautical, and Military Instruments Sections.
The Homestead, Hot Springs, Virginia.

Completely Accessible
from operating surface

dependable instruments
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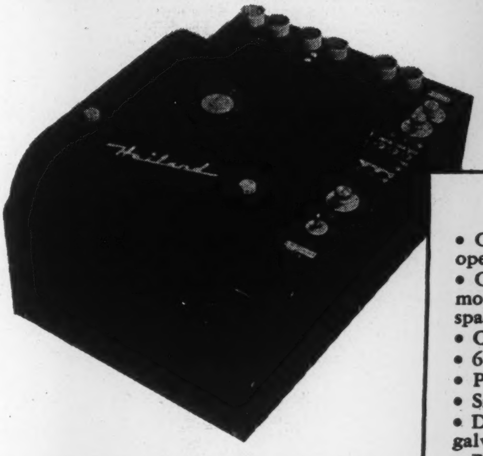
Type A-708...24-channel



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- Completely accessible from operating surface
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- 6 to 24 channels
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- Simplicity of loading
- Direct monitoring of galvonometer light spots
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- Trace identification...zero mirror...synchronizing reference trace
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AUTOMATIC OSCILLOGRAPH RECORDER

Affording complete accessibility from operating surface and requiring only a minimum of space for mounting, the HEILAND A-708 meets the exacting specifications of research and development personnel in aircraft flight testing, laboratory and industrial testing.

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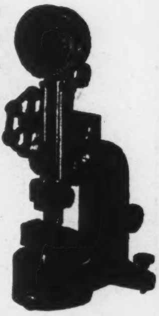
done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 42 years.

In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.



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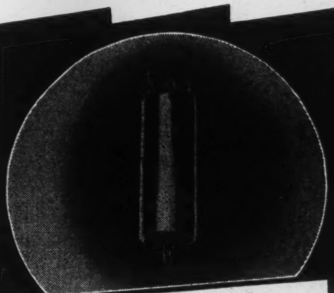
Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.
90-35 Van Wyck Expressway
Jamaica 2, N. Y.



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Filling	Hydrogen
Operating Range	-40° F to 300° F
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Plateau	300 Volts
Slope of Plateau	Depends on quenching circuit
Cathode Material	Copper
Effective Cathode Dimensions	3¼" lg. x 1¼" ID
Type of Quenching	External Quenching

*Guaranteed for one year except for mechanical damage and failure of quenching circuit.

FREE! Safety Code for Use of Radium. Write today.

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PRECISION TEN-TURN POTENTIOMETER

1. You get permanent accuracy because the resistance wire is locked in place. It is precision positioned and moulded integrally with the housing.
2. You get permanently accurate settings, smooth action and low uniform torque provided by the stainless steel, precision ground, double thread lead screw guiding the moving contact.
3. You get precise positioning of the moving contact because of the two bearings supporting the rotor assembly.
4. You get good rigid terminals because they are moulded integrally with the housing.
5. Terminals soldered to ends of resistance element before moulding. Entire resistance circuit is an integral part of the housing.
6. You get accurate setting and resetting due to anti-backlash spring in contact guide.
7. You get a fine resolution because of the 43½" length of resistance wire in the spiral element.
8. You get a resistance output directly proportional to shaft rotation within ±0.1% of the total resistance. Every potentiometer is automatically machine tested for linearity at 101 points.

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LINEARITY ACCURACY ± 0.1%

Units for immediate shipment:
1,000 to 30,000 ohm range.
Special resistance values made to order.

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Over 85% of the torque wrenches used in industry are
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in inch ounces . . . inch pounds . . . foot pounds (All Sizes from 0-6000 ft. lbs.)

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RAWSON-LUSH
Rotating Coil
GAUSSMETER

Tiny coil (approx. 3 mm diameter) rotates in the field to be measured. The voltage generated is rectified in a synchronous rectifier and used to deflect a Rawson high sensitivity voltmeter with scale calibrated in kilogausses.

Features

(1) Simple operating principles, simple to use and maintain.
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(4) Practically point measurement of magnetic field.
(5) Can be inserted in any gap larger than ¼" and will reach center of 37" diameter gap. Coil protected by stationary outer tubing.
(6) Measures direction of field as well as intensity.
(7) Guaranteed accuracy 1 per cent or better.
(8) Low Price $350.00 complete with meter.

RAWSON ELECTRICAL INSTRUMENT COMPANY
112 Potter St. Cambridge, Mass.

BOOK REVIEWS

Synthesis of Electronic Computing and Control Circuits

By the Staff of the Computation Laboratory, Harvard University

Vol. XXVII of the Annals of the Computation Laboratory, Harvard University, Harvard University Press, Cambridge, 1951. Cloth; 278 pages. Price: $8.00.

The action of vacuum-tube circuits can be simulated by mathematical operators, particularly the switching function "on-off," or "1,0." By applying this simple operator to diodes, triodes, and pentodes, it is possible to synthesize a problem and find the minimum number of vacuum tubes required to perform a given function.

The vacuum-tube operators for tubes are explained; the switching functions of two, three, and n variables are given; and minimizing charts for finding the minimum number of required tubes are given.

The technique is extended to circuits with multiple outputs, to triggers and digit counters, to rectifiers, to coding systems, adders and accumulators, and multipliers.

The book is written for engineers with knowledge of functional notation and operations.

Modern Interferometers

By C. Candler, M.A., F. Inst. P.

502 pages, amply illustrated, cloth bound. Available from The Jerrell-Ash Co., 165 Newbury St., Boston 16, Mass. Price $9.75.

This is the first book to deal exclusively with interferometers and to provide the simple theory essential for the growing number of workers who use them in astronomy, chemistry, engineering, nuclear physics, and surveying—some of the sciences in which interferometry plays an increasingly useful part.

The author deals comprehensively with interferometers, and has devoted several chapters to the diffraction grating. The instruments are grouped according to use.

Vibration and Shock Isolation

By Charles E. Crede

328 pages, amply illustrated, cloth bound. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Price: $6.50.

Mr. Crede, vice-president and chief engineer of The Barry Corporation in Watertown, Massachusetts, explains the mechanics of vibration and shock isolation, and discusses the design and application of isolators. Treating isolation from both analytical and descriptive points of view, the author provides the first book length study of his subject. Written for the practicing engineer, the book analyzes the causes of vibration and shock and evaluates the use of natural and synthetic rubbers, metal springs, felt and cork for designing isolators. Sections of the volume are devoted to the special applications of isolators to machinery. The mathematics include differential calculus.

Receiver Circuitry and Operation

By Alfred A. Ghirardi and J. Richard Johnson.

Published by Rinehart Books, Inc., New York, N. Y. 669 pages, well illustrated. Price: $6.00.

Designed to be a comprehensive text on the subject of radio receiver circuitry, this book covers principles, operation, and use of AM and FM reception, including TV. Superheterodyne, r-f., t-r-f., and FM reception principles are discussed. Emphasis is on typical circuits.

TV receivers are discussed in detail, including projection systems, and color television. A chapter on antennas includes broadcast radio and TV antennas, transmission lines, and antenna rotators. Home recorders, phonograph pickups, record players, and record changers are described, with emphasis on practical factors.

Servomechanisms and Regulating System Design (Vol. 1)

By Harold Chestnut and Robert W. Mayer

John Wiley & Sons, New York, 1951. Cloth, 6 x 9¼ in., xiii +505 pages. Price $7.75.

This book is one of a series written in the interest of the advanced course in engineering of the General Electric Company and presents the feedback control problem with the objective of training design and application engineers. The book starts from the basic mathematics, describes clearly the nature of the physical problems involved, and proceeds to the solution of advanced designs. Includes numerous problems illustrating and extending the text material.

Handbook of Power Resistors

Compiled by H. F. Littlejohn, Jr., Ward Leonard Electric Co.

Edited by Christian E. Burckel and Associates. Published by Ward Leonard Electric Co., Mount Vernon, N. Y. 195 pages, 5 x 7½ in. Price $3.00.

This handbook is designed to furnish practical knowledge of the construction of power resistors, and their application and performance characteristics. Chapters deal with fundamental definitions, standards, functions, calculations, materials used, various types, performance and application, and selection data. Included also are a list of standard stock types and sizes, steps in vitreous-enamel-resistor manufacture, NEMA resistor standards, basic definitions, tables and symbols, and bibliography and references.

SCMA Handbook

Southern California Meter Association, 2916 Eucalyptus Ave., Long Beach 6, Calif. Price $6.50.

6-ring loose-leaf handbook, 5 x 7⅝ in., includes hundreds of pages of charts, tables, graphs, and other handbook-type data in 16 sections. The subjects covered, by sections, include: (1) Gas Flow—General, (2) Gas Flow—Flange Taps, (3) Gas Flow—Pipe Taps, (4) Gas Flow—Flange & Pipe Taps, (5) Steam Flow, (6) Liquid Flow, (7) Displacement Meters, (8) Square Root Charts, (9) Flange Data, (10) Orifice Fittings & Specif., (11) Regulators, (12) Boiler Data, (13) Flow Data, (14) Conversion Tables, (15) Physical Constants, (16) Miscellaneous Data.

MICRODIAL
TEN TURN-COUNTING DIAL

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COMPACT... Microdial has same O.D. as Micropot . . . requires no more panel space.

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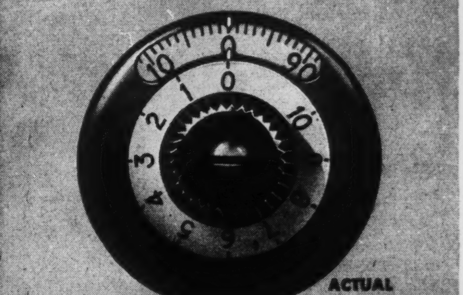

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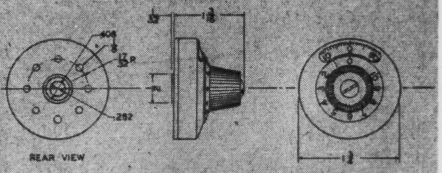

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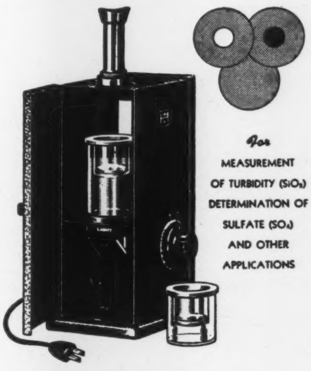

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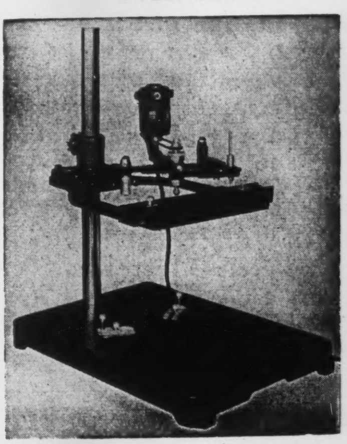

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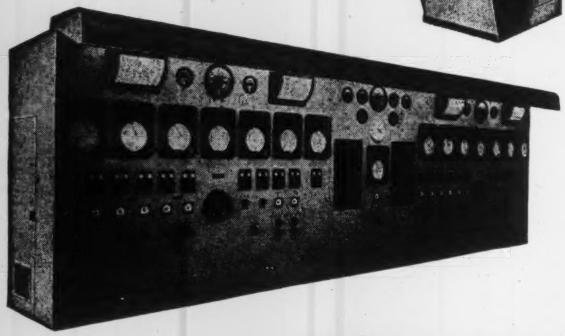

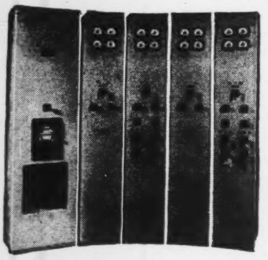

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INSTRUMENT ELECTRONICS

Continued from page 1445

grid voltage (input signal) under the condition that plate current and all other electrode voltages remain constant. The amplification factor of a medium-mu triode, such as a 6J5, is 20. A high-mu triode, such as a 6SL7, has a mu of 70.

Plate resistance. The dynamic plate resistance is the resistance of the tube between cathode and plate to flow of a.c. It is the inverse of the slope of the E_p-I_p characteristic curve, or the ratio of a small change in plate voltage to the corresponding change in plate current. The plate resistance of a 6J5 is about 7000 ohms; that of the 6SL7 is about 44000 ohms. Note that a high-gain tube has higher plate resistance.

Transconductance. The amplification of a stage depends on the change in plate current produced by a change in grid voltage. The ratio of the former to the latter $(\Delta I_p/\Delta E_g)$ is called transconductance (g_m). It is also called grid-plate transconductance or mutual conductance. It is called a "conductance" because it is the opposite of a resistance (E/I), and is measured in units of *mhos*, which is ohm spelled backwards. The transconductance of a 6J5 is about 0.003 mhos, or 3000 micromhos. That of a 6SL7 is about 1600 micromhos. Note that the transconductance is a measure of how well the grid controls plate current.

The triode has two disadvantages—interelectrode capacitance and low amplification.

Interelectrode capacitance. Capacitance exists between any two pieces of metal separated by a dielectric. The electrodes of a vacuum tube are metallic and are separated by an air dielectric. Therefore, they form small capacitors. The capacitance between electrodes, called *interelectrode capacitance,* is illustrated schematically for a triode in Fig. 5-10. The capacitances in a triode are the grid-to-cathode capacitance, the plate-to-grid capacitance, and the plate-to-cathode capacitance.

Interelectrode capacitance, though small, couples high-frequency a-c. signals from plate to grid, grid to cathode, and plate to cathode. The plate-to-grid capacitance feeds from plate to grid a small unwanted signal that can be in phase with the grid signal, thus producing instability and undesirable oscillations. The internal feedback can be *neutralized* by feeding back from the plate to the grid a second signal that is opposite in phase from (but equal in magnitude to) the unwanted feedback signal. This is done by connecting an external capacitor from the grid to a point of proper polarity in the plate circuit. Such an external capacitance is known as a neutralizing capacitor. It usually is a small variable capacitor that can be adjusted for precise cancellation of the objectionable internal feedback voltage. The grid-to-plate interelectrode capacitance of triodes limits the use of triodes as amplifiers at high frequencies.

Effect of Plate. The second disadvantage of a triode is that the signal at the plate reduces the gain of the triode and limits the maximum amplification. As shown by the characteristic curves, the plate current depends on plate voltage. As plate voltage drops, so does plate current. This limits the amplification as follows: Suppose a positive signal is applied to the grid of a triode. The positive signal causes *more* plate current to flow. This current causes a negative signal at the plate. However, a negative change in potential at the plate tends to *reduce* the plate current, which in turn raises the plate potential. Thus, the higher the gain of the triode, the more the plate overcomes the action of the grid. When the grid increases the current, the plate decreases it; when the grid decreases the current, the plate increases it. Therefore, the effect of the plate on the grid limits the amplification of the triode. This opposing action of the plate, as well as the effect of interelectrode capacitance, is reduced when the plate is shielded from the grid, as it is in tetrodes and pentodes.

TETRODES

The grid-plate capacitance within a tube and the effect of the plate on the grid can be reduced by adding a fourth element to the conventional triode. This fourth element is a second grid and is called a *screen grid.* It is placed between the control grid and plate. The four-electrode tube is called a tetrode. A tetrode tube connected in a circuit is shown in Fig. 5-11.

The screen grid is maintained at a constant positive potential that is less than that of the plate. The positive voltage on the screen grid accelerates the electrons moving from the cathode. Some of these electrons strike the screen and produce a screen current, which usually serves no useful purpose. Most electrons however, pass through the open-mesh screen grid to the plate.

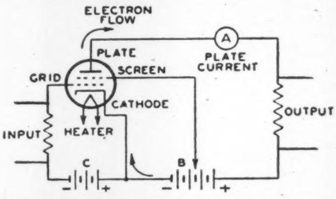

Fig. 5-11. Tetrode stage. Typical plate potential: 250 v.; control grid: minus 10 v.; screen grid: 90 v.; cathode: zero or ground potential.

The steady screen potential attracts the electrons from the cathode and makes the plate current independent of changes in plate potential. By eliminating the effect of plate potential on plate current, the screen effectively shields the grid from the plate. This eliminates the disadvantages of the triode.

Characteristic Curves

A typical family of characteristic curves of a tetrode is shown in Fig. 5-12. The dotted curve represents the screen-grid current when the control-grid bias is at −3 volts.

As the screen grid keeps variations in plate potential from affecting the plate current, the curves are fairly flat over wide ranges of plate potential. Note, however, that the plate current can be controlled completely by a small change in grid potential (0 to −6 v.).

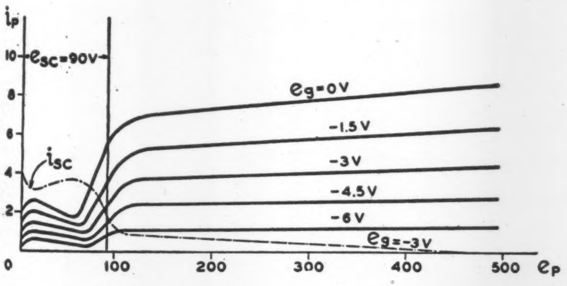

Fig. 5-12. Characteristic curves of a type 24A tetrode with screen grid at 90 volts.

Although the tetrode overcomes the disadvantages of the triode and has much higher amplification, the screen grid introduces a disadvantage—a region in which the characteristic curves have negative slope. The region in which plate current decreases as the plate voltage increases is called the region of negative resistance because the action is opposite to that of a normal, or positive, resistor. When a tetrode operates in this region—that is, when the plate voltage is fairly low—the output signal is distorted and the tube can oscillate.

The negative slope is a result of *secondary emission* from the plate. When electrons strike the plate, some electrons (called secondary-emission electrons) are knocked off the plate into the space between the plate and screen. When the screen is at a higher potential than the plate these secondary electrons are attracted to the screen. In the region of negative resistance, the secondary electrons increase in number faster than the primary electrons for a given increase in plate voltage. As the secondary electrons leave the plate, the plate current decreases. If the plate

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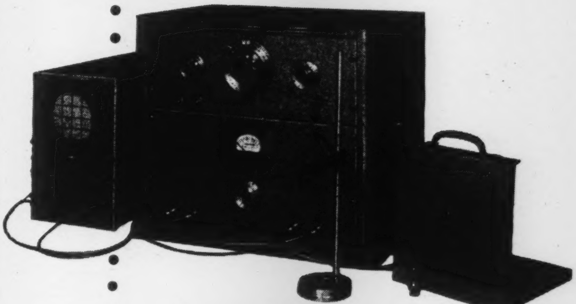

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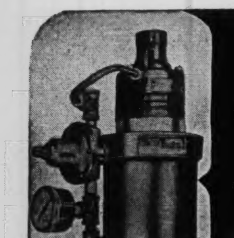

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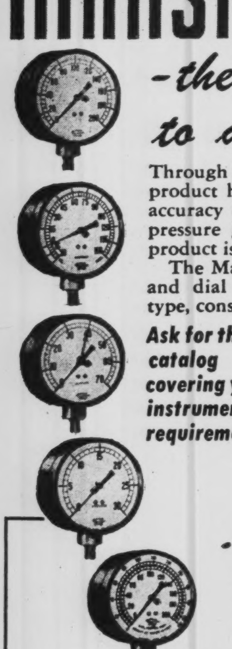

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potential is made higher than the screen potential, the secondary electrons are attracted back to the plate and the plate current again increases.

The advantages of the tetrode over the triode are (1) reduced grid-plate capacitance, (2) higher amplification, and (3) greater power sensitivity. It has the disadvantage of secondary emission. A fifth element can be added to overcome the effect of secondary emission.

PENTODES

A third grid between the plate and the screen (Fig. 5-13) eliminates the effect of secondary emission. Tubes with this third grid are called *pentodes* because they have five electrodes—three grids, one plate, and one cathode. The third grid is called the *suppressor grid.*

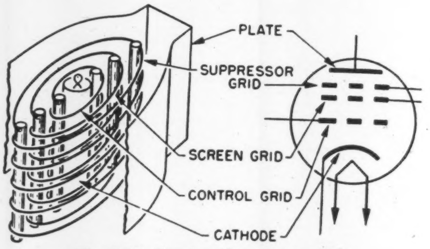

Fig. 5-13. Construction of a pentode.

The suppressor grid usually is connected to the cathode (Fig. 5-14). As it is much more negative in potential than the plate, it repels secondary electrons back into the plate from which they were ejected. This eliminates the objectionable region of negative resistance and permits a smooth rise of plate current from zero up to its saturation point, as shown by the characteristic curve (Fig. 5-15).

The amplification of pentodes and tetrodes is higher than that of triodes because the opposing action of the plate is shielded from the grid. The plate resistance of pentodes also is higher than for triodes. For example, the a-c. plate resistance of a typical pentode, the type 6SJ7, is about 700,000 ohms. Its d-c. resistance is lower.

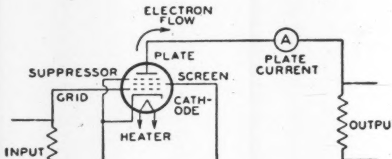

Fig. 5-14. Pentode amplifier stage. Typical plate potential: 250 v.; control grid potential: minus 3 v.; screen-grid potential: 100 v.; suppressor and cathode: 0 v.

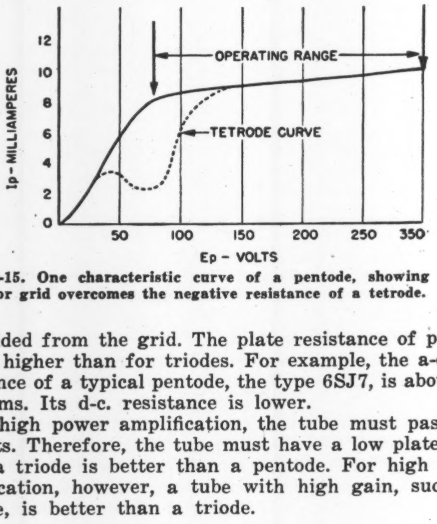

Fig. 5-15. One characteristic curve of a pentode, showing how the suppressor grid overcomes the negative resistance of a tetrode.

For high power amplification, the tube must pass large currents. Therefore, the tube must have a low plate resistance; a triode is better than a pentode. For high voltage amplification, however, a tube with high gain, such as a pentode, is better than a triode.

BEAM-POWER TUBES

A beam-power tube is a pentode designed for high power output. The suppressor grid is a specially shaped electrode that controls the space charge of secondary electrons near the plate. The plate current is made to flow in a concentrated beam from the cathode, through the grids, to the plate. In addition to the beam-forming plates, the beam-power tube differs from the ordinary tetrode and pentode in that the sapces between the turns of the grids are lined up. Fig. 5-16 shows the internal construction of a beam-power tube.

As the spaces between the turns of the grids are lined up, fewer electrons strike the screen grid. This decreases the screen current and increases the plate current and power output of the tube.

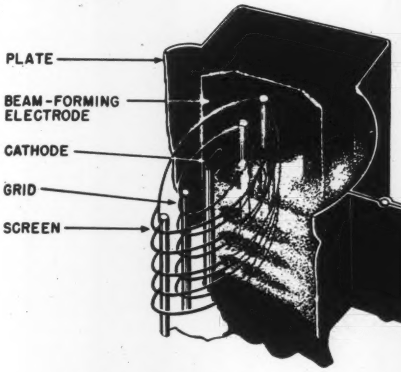

Fig. 5-16. Construction of a beam-power pentode.

Beam-power tubes are used widely as power amplifiers in electronic circuits. Typical beam-power tubes are the 6L6 and 6V6 tubes.

VARIABLE-MU TUBES

Variable-mu tubes, as the name implies, are tubes designed so that their amplification can be varied. They usually are pentodes with a special kind of control grid. In a conventional pentode the control grid is made of equally spaced wires; in a variable-mu pentode the control grid is made of an unequally spaced spiral—that is, the wires are close together at the top and bottom of the grid but are spaced wide apart at the center. When small negative voltages are applied to the grid of a variable-mu tube, the electrons from the cathode flow through all the spaces in the grid. As the voltage is made more negative, however, the electrons can no longer pass through the narrow spaces on the ends of the grid structure but can pass through the larger spaces at the center of the grid. Thus, a much greater negative voltage is required to cut off the plate current in this type of tube.

A characteristic of the variable-mu tube is that the gain decreases as the negative grid-bias increases. Hence the name "variable-mu." The tube is known also by several other names, including *supercontrol* and *remote-cut-off tube*.

MULTIGRID AND MULTIUNIT TUBES

Vacuum tubes may be constructed with four, five, or six grids to obtain certain characteristics. Tubes with these extra grids are used to mix several signals. When different signals are applied to the various grids, the plate current is controlled by each grid and has some of the characteristics of each signal. Such tubes are called converters and mixers.

To reduce the number of tubes in radio circuits the electrodes of two or more tubes frequently are placed within one envelope. These complex tubes usually are named according to the types of tubes inside the envelope. Thus a twin-triode contains the electrodes for two triodes in one envelope. The 6SN7 and 6SL7 tubes are twin triodes. One type of tube combines the functions of three tubes in one

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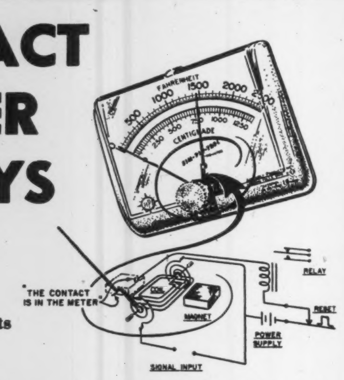

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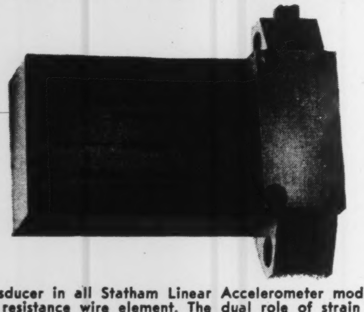

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envelope—a diode, a triode, and a power-output pentode. Each type of tube within the envelope operates independently of the others, although one heater is used to heat the several cathodes.

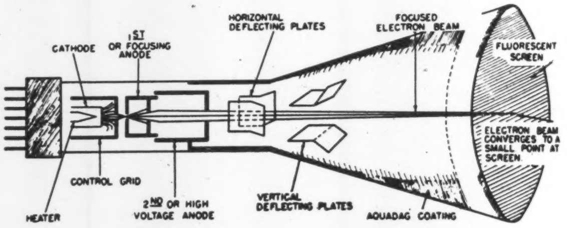
CATHODE-RAY TUBES

The cathode-ray tube is the heart of the oscilloscope and the television receiver. It is a most interesting and useful tube because it makes it possible to "see" electric signals.

In the cathode-ray tube the cathode emits electrons which are focused into a sharp beam by a focusing anode. The focused beam strikes a phosphor, which fluoresces and makes the point of impact visible. The intensity of the beam and the brightness of the spot are controlled by the grid bias.

Voltage or current signals can be seen on the face of the screen by applying the signals to either the horizontal-deflection or the vertical-deflection plates. The electrons in the beam are so light that they move instantly in response to the signals, thus making the signals visible on the face of the tube.

In the electrostatic-type cathode-ray tube (Fig. 5-17), the focusing and deflecting of the beam is done by electric fields. In the electromagnetic-type cathode-ray tube, the focusing and deflecting is done by a magnetic field. The former is superior for small-size tubes (up to 7-in. diameter); the latter is superior for larger tubes.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CONTROL GRID
2ND OR HIGH VOLTAGE ANODE
VERTICAL DEFLECTING PLATES
AQUADAG COATING
HEATER

Fig. 5-17. Electrostatic-type cathode-ray tube.

SPECIAL U-H-F. TUBES

At frequencies below 100 megacycles the *transit time* of the electrons, which is the time required for the electron to travel from cathode to plate, is insignificant compared to the period of one cycle. However, at higher frequencies the transit time, which is about 0.001 microsecond, becomes of the same order of magnitude as the time of a cycle. This causes an undesirable shift in phase at the plate, which in turn causes instability.

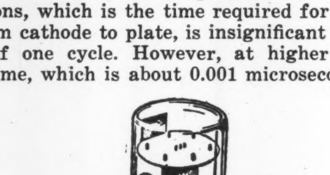

Fig. 5-18. Acorn-tube triode.

The amount of interelectrode capacitance, the effect of electron transit time, and other objectionable features of ordinary vacuum tubes are minimized in the construction of special tubes for use at ultra-high frequencies. These u-h-f. tubes have small electrodes placed close together and no socket base. By a reduction in all physical dimensions of a tube by the same scale, the interelectrode capacities are decreased without affecting the transconductance or the amplification factor. Although the transit time is reduced, so is the power-handling capacity of a tube of small dimensions.

Fig. 5-18 shows the "acorn" type vacuum tube designed specially for u-h-f. operation. These small tubes are available as triodes, diodes, and pentodes. An enlarged version of the acorn types, known as the "door-knob" tube, operates at higher powers and at frequencies as high as 600 megacycles.

For frequencies above 500 megacycles, tubes known as *klystrons* and *magnetrons* are used. These tubes utilize electron transit time in their operation. Klystrons are used commonly as local oscillators in u-h-f. receivers. Magnetrons are used commonly as high-power r-f. oscillators in radar equipment.

TEST ITEMS FOR—V. VACUUM TUBES

5-1. The function of a filament in an electron tube is to
- (a) heat the plate
- (b) heat the cathode
- (c) emit electrons
- (d) attract electrons

5-2. The function of a cathode of an electron tube is to
- (a) heat the plate
- (b) heat the filament
- (c) emit electrons
- (d) attract electrons

5-3. The number of electrons emitted from an emitter depends on
- (a) the temperature of the emitter
- (b) the type of emitter
- (c) the atmospheric pressure around the emitter
- (d) all the above

5-4. The type of emitter used in most conventional vacuum tubes is
- (a) tungsten
- (b) thoriated tungsten
- (c) oxide coated
- (d) filamentary

5-5. A disadvantage of indirectly heated cathodes is
- (a) more a-c. hum
- (b) separate heater and cathode circuits
- (c) less efficiency
- (d) all the above

5-6. Below the saturation point, the plate current through a diode is controlled primarily by the
- (a) plate voltage
- (b) plate temperature
- (c) cathode temperature
- (d) number of electrons emitted from cathode

5-7. The number of electrons emitted from a cathode depends only on
- (a) plate voltage
- (b) plate temperature
- (c) cathode voltage
- (d) cathode temperature

5-8. A diode is a rectifier because the
- (a) electrons are emitted in large number
- (b) plate current flows in only one direction
- (c) filament heats the cathode
- (d) electrons have a negative charge

5-9. The peak inverse voltage of a diode refers to the maximum amount by which the
- (a) cathode can be more positive than the plate
- (b) plate can be more positive than the cathode
- (c) cathode can be more positive than the filament
- (d) filament can be more positive than the cathode

5-10. At any one point on the characteristic curve of a diode, the ratio E_p/I_p is the
- (a) d-c. plate resistance
- (b) dynamic plate resistance
- (c) plate impedance
- (d) plate conductance

5-11. The grid potential of a triode has greater control of plate current than the plate potential because the grid
- (a) has a negative potential
- (b) has spaces between the wires
- (c) is closer to the cathode
- (d) has a higher potential

5-12. In order to control the plate current, the grid of the triode should be
- (a) more positive than the plate
- (b) more negative than the cathode
- (c) more positive than the heater
- (d) more negative than the heater

5-13. The characteristic curves of a triode show how I_p varies with
- (a) E_p only
- (b) E_g only
- (c) I_g and E_g
- (d) E_p and E_g

5-14. The gain of a triode amplifier stage depends on
- (a) the plate potential
- (b) the grid potential
- (c) the plate load
- (d) all the above

5-15. The maximum possible gain of an amplifier tube is called the
- (a) mu
- (b) transconductance
- (c) plate resistance
- (d) gain

5-16. The output signal of an amplifier stage is
- (a) in phase with the input signal
- (b) 90 degrees out of phase with the input signal
- (c) 180 degrees out of phase with the input signal
- (d) 270 degrees out of phase with the input signal

5-17. The source of plate potential of a tube is called the
- (a) A supply
- (b) B supply
- (c) C supply
- (d) D supply

5-18. In a triode, the interelectrode capacitance which causes instability is the
- (a) plate-to-grid capacity
- (b) plate-to-cathode capacity
- (c) grid-to-cathode
- (d) any of the above

5-19. The plate limits the maximum amplification of a triode because
- (a) of interelectrode capacitance
- (b) of low plate resistance
- (c) it opposes the grid action
- (d) it has no effect on plate current

5-20. The transconductance of a tube is a measure of
- (a) grid control of plate current
- (b) plate control of plate current
- (c) grid control of plate voltage
- (d) any of the above

5-21. The screen potential of a tetrode amplifier should be
- (a) higher than that of the plate
- (b) lower than that of the control grid
- (c) lower than that of the plate
- (d) same as that of the cathode

5-22. The tetrode overcomes the

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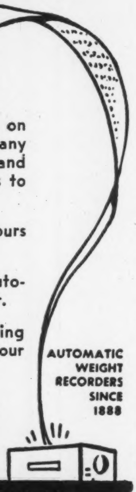

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disadvantages of the triode by making
(a) plate current independent of grid potential
(b) plate current independent of plate potential
(c) plate current independent of screen potential
(d) plate current dependent on screen potential

5-23. The negative-resistance region of the tetrode characteristic is caused by
(a) secondary emission
(b) high plate potential
(c) low screen potential
(d) low grid bias

5-24. The function of the suppressor grid of a pentode is to
(a) keep secondary-emission electrons from being produced
(b) repel secondary-emission electrons back to the plate
(c) accelerate electrons in the plate current
(d) decelerate electrons in the plate current

5-25. The grids of a beam-power tube are constructed so that
(a) plate current is minimized
(b) screen current is minimized
(c) grid current is maximum
(d) screen potential is maximum

5-26. A variable-mu tube is characterized by
(a) a control grid of unequal spacing
(b) a screen grid of high potential
(c) a plate of low potential
(d) a screen grid of special alignment

5-27. Multigrid tubes with 4 or 5 grids are used for
(a) obtaining several stages in one envelope
(b) obtaining higher amplification
(c) reducing secondary emission
(d) mixing several signals

5-28. The signal to be observed on the electrostatic cathode-ray tube of an oscilloscope should be applied to the
(a) deflecting plates
(b) focusing anode
(c) control grid
(d) cathode

5-29. The intensity of the spot in a cathode-ray tube is controlled by the
(a) focusing anode
(b) vertical-deflection plates
(c) horizontal-deflection plates
(d) grid bias

5-30. The transit time of electons in a vacuum tube becomes important and troublesome when
(a) a triode or pentode is used
(b) the distance from cathode to plate is small and the plate voltage is high
(c) the transit time is of the same order of magnitude as the time of one cycle
(d) frequencies below 10 megacycles per second are being amplified

DIELECTRIC MEASUREMENT

Continued from page 1438

residual quadrature unbalance signal adversely affects the performance of the amplifier and rebalancing mechanism; commercial installations of this type of apparatus have been primarily to measurement of air-dielectric capacitors rather than to dielectric measurements.

FUTURE PROSPECTS

Except for the measurement of weight and moisture of sheeted material, continuous industrial capacitance measurement is still in its infancy. The general trend toward continuous direct measurements on product means that growth in this direction is to be anticipated. There is considerable development required in the measuring elements for conversion of dielectric properties into capacity variation.

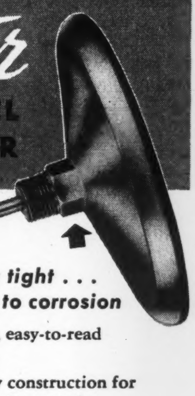
Correction and compensation techniques also require development. This is an application problem, with each particular setup requiring a compensating system adapted to the particular situation. Cooperation between the user and the manufacturer of the measuring equipment should work out adequate solutions.

There has been a certain amount of experimental work on special units for extreme sensitivity. If these work out satisfactorily, higher measurement sensitivities will be available at a reasonable price for general industrial application.

There appears to be a bright future for continuous industrial dielectric-measuring techniques. Work is being carried on in university and industrial research laboratories on the effect of frequency, potential, and temperature on the dielectric constant and dielectric losses of materials. It is established that characteristic variations do occur and that analysis of a group of measurements can yield information about the material being measured.

The industrial application of these techniques even to static samples is limited by the amount of basic information currently available. The laboratory instrument manufacturers are already marketing standard instruments for this type of measurement.

As techniques for determining the characteristics of materials from a multiple-valued measurement of dielectric



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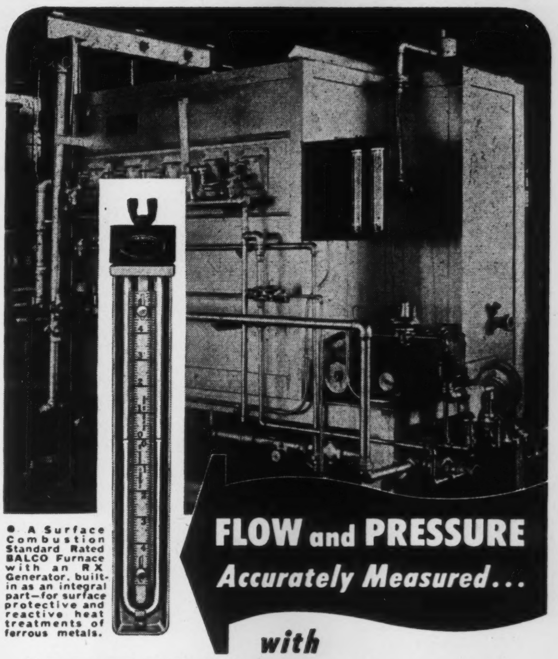

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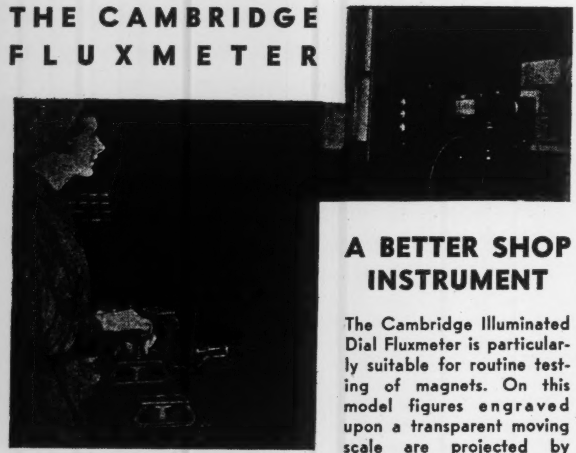

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properties become established, there is every reason to believe that the basic information can be extended to apply to measurement and control of continuous industrial processing. This will, of course, require instrumentation as yet not even conceived. However, once the demand exists and the specifications are laid down, experience has shown that the necessary apparatus will be forthcoming.

The developments during the past twenty years in spectroscopy and similar directions, and the applications of these techniques to continuous process operation is most encouraging. The dielectric properties of materials are fundamental characteristics. There appears to be a promising field for progress in the measurement of these dielectric properties and their interpretation in terms of product characteristic.

DISCUSSION

M. K. Andersen: Could variation in pressure in a gas be detected by measurement of dielectric constant?

W. H. Howe: I believe it could. We do not have any actual experimental data. At atmospheric pressure the change in pressure would be small. However, the use of higher pressures should increase the sensitivity.

Adams: Has dielectric measurement been applied to the measurement of coal?

Howe: Not that I know of. I should think that it would be possible using a technique similar to the turntable, which I described, for well-crushed samples of coal. There would be a question as to how evenly the coal would pack; if this packing is irregular, the measurement of the power factor, or "Q," would probably help considerably.

Walt: What is the effect of the humidity of the air in the dielectric measurements of solids where the capacitor is partly filled with air?

Howe: None. The dielectric constant of dry air or of air with moisture in it is so near to 1.0 that the variation is negligible from the practical standpoint. It does have an effect but the magnitude is extremely small.

C. W. Bates: What is the stability of practical instruments available today in parts per million?

Howe: The only "practical instrument" we can offer has a full-scale value corresponding to 6 percent capacity change. The stability of this instrument is 1 percent of scale, which would be 0.06 percent capacity change or 600 parts per million. On some experimental work which we are carrying on, we hope to arrive at a stability approximately one hundred times as good. It's purely a matter of good electrical engineering to increase this stability to almost any desired value. The present standard instrument has a stability of about six hundred parts per million, which can be bettered appreciably by stabilizing temperature and voltage.

Foteling: For liquids having about the same dielectric constant, could temperature be a help in establishing a differential dielectric constant in order to achieve a measurement?

Howe: I think it could. It would appear that the easiest way to do this would be to run the combination at an elevated or reduced temperature where the dielectric constant would actually be different. The values which I read were rounded off to the nearest figures. Most liquids do have a sufficient difference in dielectric constant for measurement purposes.

It may be mentioned that it is difficult to detect small quantities of low-dielectric-constant material in the presence of larger quantities of high-dielectric material. If the dielectric constants differ by more than two or three to one, the dielectric constant of the whole is appreciably different from the weighted average of the dielectric constant times mass of material due to the fundamental reciprocal relationship which applies to the addition of series capacitances.

Andersen: Frequency is a factor to reckon with in dielectric constant measurement, that is, dielectric constant is measurements of dielectric constants, possibly measuring at two or three different frequencies? Perhaps summing the frequency-sensitive. Could this be made a help in the

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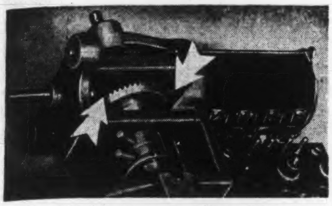

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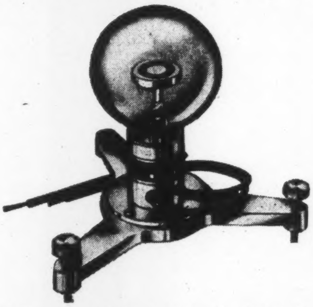

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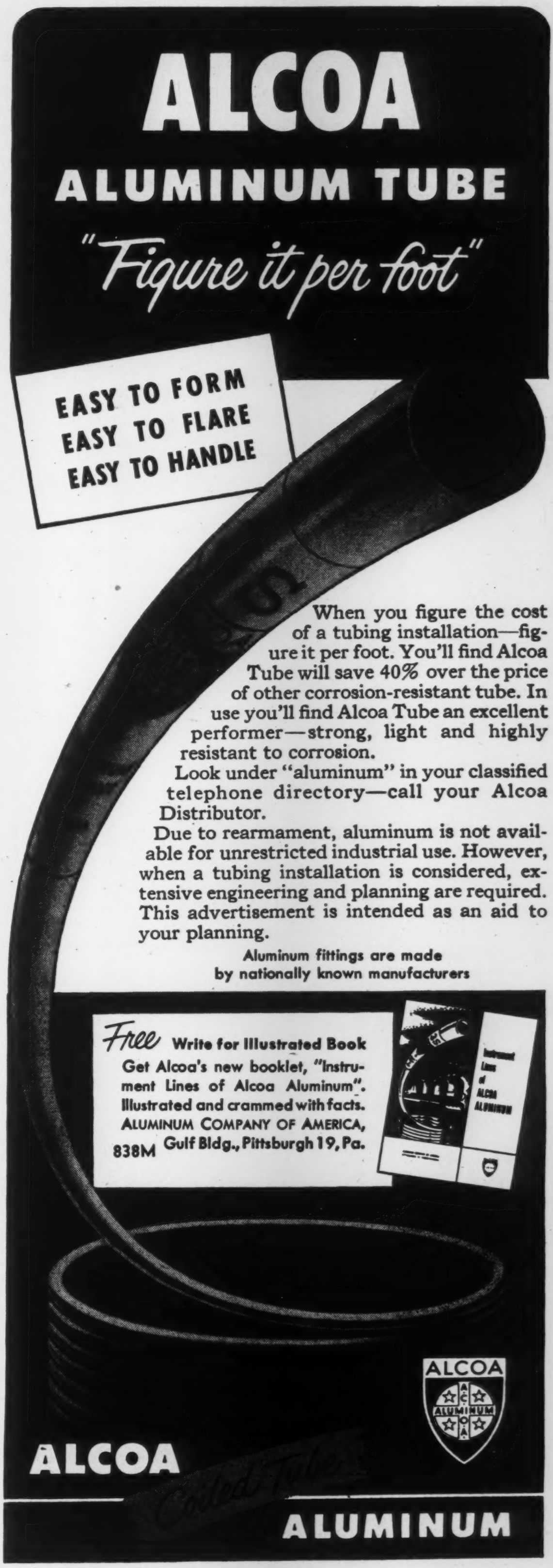
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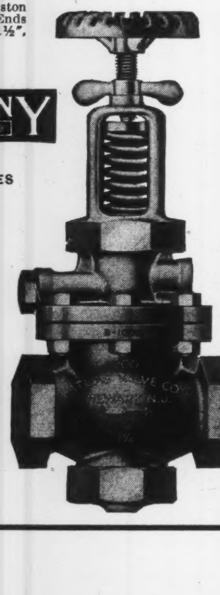

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net results up could be used to distinguish specific factors in a compound?

Howe: I strongly believe that this could be an effective technique. Exactly what happens on salient point resistance and capacity effects, I am not enough of a theorist to know. E. H. Sargent & Company, 4647 W. Foster Ave., Chicago 30, Ill., in their publication, "Scientific Apparatus and Methods," Volume 4, Spring, 1951, gave a lot of data on this approach. They showed a number of curves of frequency versus dielectric constant where the variation was pronounced. When and if these factors are determined, this should be a relatively easy technique to apply. It would be comparatively easy to provide instruments to measure at several different frequencies. I feel that apparatus of this type has powerful analytical potentialities.

Andersen: Where you have films with a moisture content in the film, could you use different frequencies to eliminate the moisture factor or to read both weight and moisture simultaneously?

Howe: I am sure that this can be done, although it has not yet been developed for continuous measurement. Some ten or fifteen years ago Dr. A. C. Walker, of the Bell Laboratories, measured the moisture content of sealed paper capacitors by dielectric measurements at varying frequencies and, as I remember, at varying temperatures. He got reliable results. I think the data was published in the Bell Laboratories Journal, but I am not sure. I got this information from him personally.

Wilson: What is the maximum distance that the plates of measuring capacitance could be spaced and still have normal operation?

Howe: For dry sheet material we have not run widely spaced plates. Normally, we operate at about a quarter inch spacing. As you separate the plates, you increase the stability requirements of the electrical circuits. When you separate the plates, you decrease both total capacity and sensitivity, and hence doubling plate spacing quadruples the required electrical sensitivity and stability. However, the required accuracy and stability of the actual plate spacing is not increased and hence the mechanical and structural problems are no worse with wide plate spacing. Since the most serious limitations are in these mechanics, it would appear possible to increase the plate spacing considerably. At the present time, I know of no commercial apparatus available for continuously measuring capacity variation at high sensitivity.

Andersen: Is shielded or twisted lead wire required in the commercial industrial instrument?

Howe: Yes, we use a standard shielded lead; the lead has a second-order effect on the measurement. The lead comes in selected lengths. Unused lengths should be coiled up; please don't cut it off. The lead itself is simple shielded concentric cable.

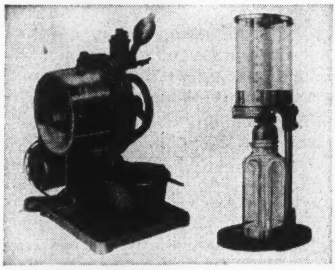
Andersen: Would you comment on the structure of your element as shown on the slide. Particularly, can you give us any data on materials of the construction.

Howe: The actual structure shown is entirely 316 stainless steel with Teflon insulators. A fiber glass-melamine washer is used as a backer behind the main Teflon insulator for stiffness and to prevent cold flow. We have tested one of these elements for 5,000 pounds pressure. The materials of construction are dictated by the service to which they are to be applied.

Andersen: Would you comment on the fire and explosion hazard of the installation such as shown in the slide.

Howe: The actual measuring element structure is a relatively low-power device. As shown in the slide, there is a "head box" associated with the measuring element. This head box contains a coil and trimmer condenser with a maximum power level of a few milliwatts and a power per cycle less than one erg.

It is a simple matter to use a regular Crouse Hinds explosion-proof box instead of the normal fitting for the head. The actual element which immerses in the liquid is out of harm's way anyhow. The cable is readily handled through conventional explosion-proof conduit; the actual measuring



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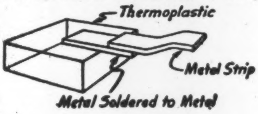

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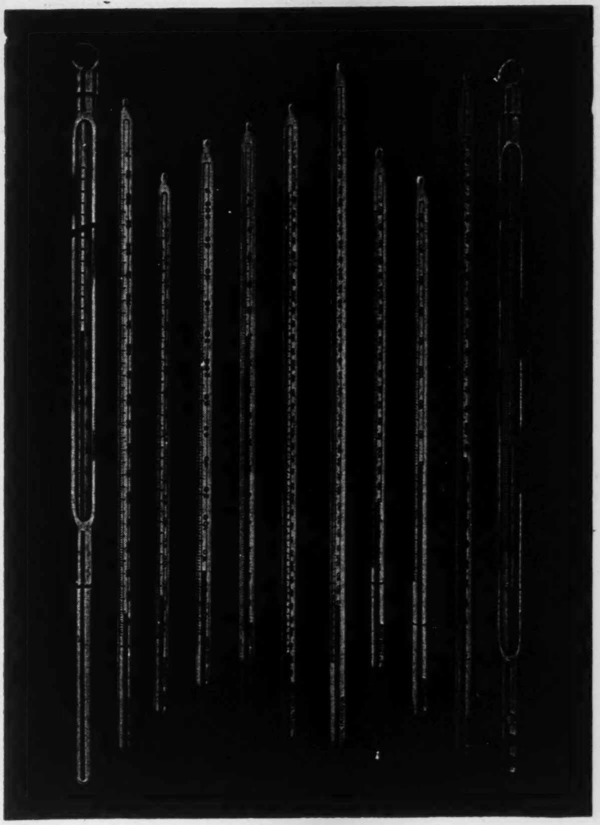

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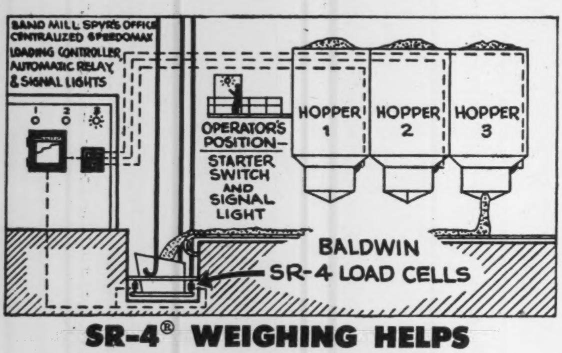
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instrument itself should of course be placed in a nonhazardous location.

Graves: Have you considered using some of the circuits similar to those used by some of the capacitor manufacturers, using simply a measurement of the current as a measure of the capacity?

Howe: No, we have not—for two reasons. In the first place, we are concerned with the ability to separate the measuring head from the actual measuring instrument. The coupled resonant-circuit arrangement leads itself conveniently to that. The second factor is that the resonant circuit provides an appreciable multiplication of voltage. This reduces the amount of amplification required and, if properly designed, increases the stability of the over-all system. An additional factor lies in the particular resonant circuit which we employ. At a particular "null" value of capacity, reasonable changes in the "Q," or power factor, of the circuit have no effect on the instrument reading.

Andersen: Will you elaborate on the dielectric constants—possibly giving a list of some of them to help out possible users.

Howe: This data in Lange's "Handbook of Chemistry," 7th edition.

Baird: What treatment do you recommend for measuring the dielectric properties of conducting liquids?

Howe: We haven't done too much with fully conducting liquids. However, we have measured materials such as pure ethyl alcohol, which have appreciable conductivity. While measurements have been made in the laboratory on highly conductive materials, it is our opinion that the dielectric constant is not a practical approach to materials of this kind. On high-conductive materials you have the actual fluid conductivity; the dielectric losses are high; these two tend strongly to mask the effect of dielectric constant.

For measurement of materials of moderate conductivity, the use of a series capacitance helps appreciably. This series capacitance reduces the effect of both dielectric losses and direct conductivity.

Henry Falcon: Have you tried the use of "Q" measurements in the electrical pickup?

Howe: We have done a certain amount of development work looking toward measurements of "Q." The electrical measuring system of course is considerably more complex than for a measurement of straight "C." However, it is one of the things which when developed should appreciably broaden the scope of the entire dielectric technique.

PNEUMATIC OPERATORS

DISCUSSION

Continued from page 1433

for a given thrust considerably. Specifically, we can say that a 4-in. piston using 100-psi. operating air, and capable of thrusts up to 1000 lbs., can be moved through a 2-in. travel in from 2 to 4 seconds easily; the same force and stroke, using lower air pressures, on a diaphragm motor might take from 10 to 15 seconds. In speaking of rates of stem movement, one must also keep in mind the stability factor; we feel that the pistons have much more to offer on this point than any diaphragm-type operator.

Parten: What information have you on the rate of positioning on the rotary gear-driven positioning mechanism?

Werey: The gear-driven unit can be made for stem travels as high as 36 in. and as low as 1 or 2 in. We normally calculate the total time of travel on the basis of certain maximum rates of stem travel. The average rate is from 10 to 12 in. per minute; however, it can be furnished up to 40 and 50 in. per minute.

Wootes: Do you build pistons of this type to operate at 1000-psi. pressure?

Werey: The problem in building a piston for this air pressure hinges directly on the availability of a pneumatic relay designed for such high pressures. To the best of my knowledge, there are no such devices available today.

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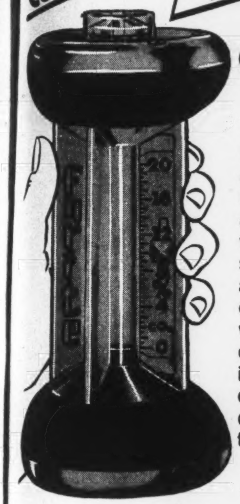

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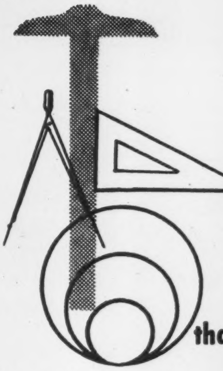

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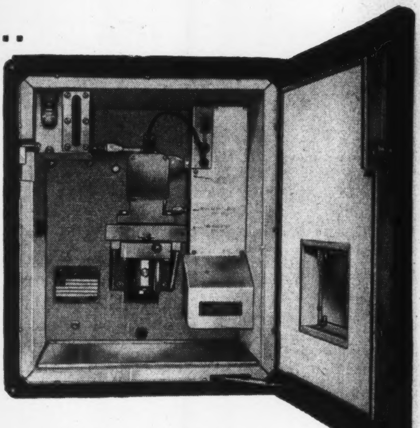

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Volume 7 December 1951 Number 12

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THE SECRETARY'S PAGE

Richard Rimbach

THIS will be the last message you will read on this page from your present executive secretary. I have met many of you during the organization of the several local instrument societies and look forward to resuming these contacts now that the burden of the National Office has been lifted from my shoulders. The amended Constitution, which was recently sent to you has received an overwhelming vote by the members. Under the new Constitution the operation of the National Office changes; the post of Executive Secretary is replaced with a Secretary and the Management of the Society will be in the hands of a Manager.

The post of Manager was filled by the Executive Committee on September 1st by the employment of Mr. Percy Jones. Mr. Jones has had extensive experience in Society matters having formerly served the American Petroleum Institute. I ask for him the very fine cooperation you have extended to me during the seven years I held the executive secretary's post.

With the increased activities of the Society more office space, than is available at the present address, is needed. Mr. Jones has been looking for new quarters for several weeks and has found a suitable location. **The National Office will therefore be moved to 1319 Allegheny Avenue, Pittsburgh 33, Pennsylvania, by the first of the year.**

With my return to the status of Member of the ISA I hope that each of the sections will place my name on their mailing lists and thus keep me advised of their meetings.

Finally, I take this opportunity to extend my very best wishes for a Merry Christmas and a Happy New Year to all of you.—RICHARD RIMBACH

Section Affiliates with Engineer Federation

Jerome J. Schwab, Secretary, advises that the Twin Cities Section has recently been approved for affiliation with the Minnesota Federation of Engineers by the Board of Directors of that organization.

The Section plans to take an active part in Federation functions and also to use its monthly publication to publicize the local ISA activity. The Federation is composed of 16 technical societies and engineers clubs in Minnesota.

The Control Valve in Operation

By WILMOT H. KIDD* and GEORGE A. PHILBRICK**

ABSTRACT. The importance of the control valve in the control circuit is shown, indicating that the flow properties of the valve and associated piping should be suitable to the essential property of the regulating controller; i.e. the proportioning band or sensitivity. Emphasis is placed on the final flow-stroke relationship, which is shown to be noticeably affected by the pressure drop in the line and equipment. The idea of equivalent orifices in a large line allows a presentation, by graphical means, showing the effect of valve size, total system pressure, and line resistance, on the important relationships among the valves, instruments, and line of flow. It is hoped that this work will stimulate additional interest and further publications on the important subject of control valve characteristics.

During recent years the exponential, or so-called equal percentage valve has enjoyed an enviable reputation but, too often, it seems to have been considered desirable without a full appreciation of the basic contribution of its characteristic. It is the primary intent of this paper to point out, largely by graphical means and through the liberal usage of dimensionless ratios, the inherent relationships which exist among the process, the valve and the controller. It is hoped to direct attention to the factor of "line drop," in the presence of which this type of valve is more nearly capable of maintaining, to an acceptably constant degree, the all important flow-stroke relationship. An indication follows as to why many control applications require more than the response of a modern high performance regulator in order to produce truly effective results.

On a numerical basis, a predominant majority of the control valves used in industry today, is of the diaphragm actuated slide stem construction and undoubtedly a majority of this group is actuated by air pressure. Owing to the familiarity on the part of the authors, the remarks of this paper are confined to such valves. For the purpose of this work, it is also considered advisable to limit ourselves to the consideration of continuous processes only. These limitations restrict the scope to an extent which leaves much ground uncovered, but it is hoped that this brief presentation may serve to stimulate further work on the subject.

A graphical method of demonstration has been elected as the one most suitable for the analysis of the several relationships making up the problem. The mathematics needed and used have been confined exclusively to the Appendix. The figures carry symbolic notations for some of the dimensionless ratios used, but these are included there for convenience. Though these ratios are identified descriptively in the text, exact definitions will be found in the Appendix.

DEFINITION OF TERMS

As an introduction for those readers who may be newcomers to the field of automatic control, the diagram given in Fig. 1 is of a standard, diaphragm actuated, slide stem type of control valve, as installed in a flow line. An inner valve plunger moves as a result of regulator air pressure on the diaphragm which is opposed by the spring and is attached to the inner valve by means of the stem.

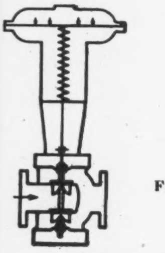

Fig. 1. A modern diaphragm-operated control valve.

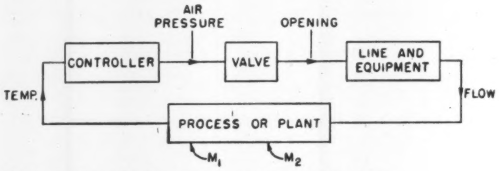

Fig. 2. The control loop, showing the position of the valve.

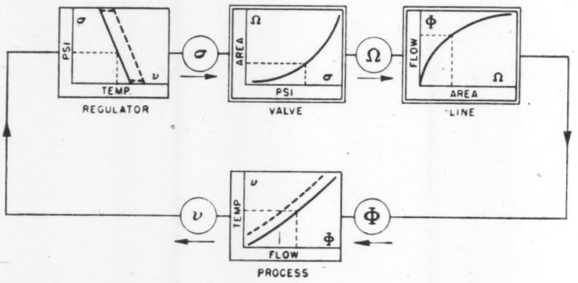

Fig. 3. The control loop again, in terms of the graphical characteristics of its elements.

The rate at which the effective hydraulic areas are developed can be determined by shaping the ports exposed by the motion of the inner valve plunger, away from or toward the seat rings. These will be discussed later, in greater detail.

The term *Linear Valve* has been used to describe a valve, the effective port opening of which is directly proportional to the stroke of movement of the actuating mechanism. As the term implies, doubling any given stroke produces an opening which is double the previous opening.

The construction of valves of the *V-Port* or *Parabolic* type is such that the effective port area is a linear function of the square of the stroke of the stem or motion of the actuating mechanism. In general, it may be said that the properties of the V-Port valve lie somewhere between those of the linear and the exponential.

The terms *Exponential* or *Logarithmic* have been used to apply to the so-called equal percentage type of valve characteristic, in which equal changes in stroke cause equal percentage changes in the effective area for all valve openings.

VALVE, CONTROLLER, AND PROCESS

To fix the relative position of the regulating valve in the cause and effect sequence which is common to all controller applications, Fig. 2 is submitted. The so-called paths of "influence" are shown by the arrows. The usual condition is likewise indicated in that the process is being affected not only by the corrective flow from the valve but also by external influences (M_1, M_2 etc.) which cause process unbalance[2].

In addition to the supply of corrective action to the process when conditions of unbalance occur, the control engineer must consider the interaction between the properties of the valve and the properties of the network in which it may be installed. This report is, in a large degree, dedicated to a more general consideration of this interaction.

Of the many controllers required in industry for the continuous type process, a large group require a response which is either solely the proportional position type[1,5,6], or this type in combination with other refinements such as the derivative or the floating responses. Such refinements are additive to the proportional action which is still the powerful basic "medicine" of control correction.

---

*W. H. Kidd and Company, 300 E. Main St., Richmond, Virginia.

**G. A. Philbrick Researches Inc., 230 Congress St., Boston (10) Mass.

NOTE: Presented before the Fifth Annual Convention of the Instrument Society of America, at Buffalo, N. Y., Sept. 18-22, 1950.

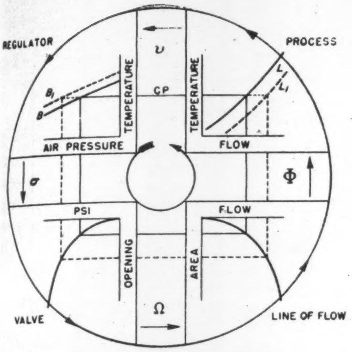

Fig. 4. Cyclic representation of Fig. 3.

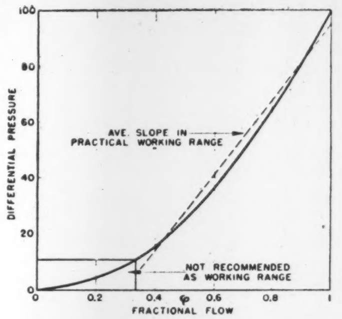

Fig. 5. Square-root flow response characteristics.

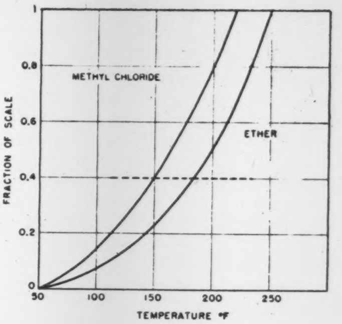

Fig. 6. Characteristic for two typical thermal filling mediums.

The valve is opened or closed gradually and "proportionally" through a range or zone of the measured condition known as the proportional band. The magnitude of this band is usually adjustable within the regulator, the chosen adjustment being a function of the process to which it is applied[7,8,9,10].

The inherent property of this type regulator, which is of keen interest here in relation to the control valve, is its administration of a correction which is uniformly proportional to the position of the measured variable within the proportioning band. The correction takes the form of a fluid pressure which is applied to the actuating diaphragm or mechanism of the valve.

Reaction Between Valve and Flow Network.

For the purpose of focusing attention more directly on the reaction between the valve and the flow network, to delineate the proportionality characteristics, and to give a preliminary introduction to some of the notations used later, Fig. 3 will be found diagrammatically similar to Fig. 2. In the regulator block it will be noted that, through a band of the measured variable (in this case temperature) there is a definite change in the corrective output pressure for each unit of change in temperature. The dotted lines indicate a change in setting, a change in load, or possibly automatic reset action by the regulator.

The opening paragraph above mentions the flow-stroke relationship. This relationship is, in reality, a ratio, and for characteristic reaction curves, such as those indicated in the various blocks of Fig. 3, this ratio is actually the slope at any point of the various curves. By changing the magnitude of the proportional band, for instance, a unit change in the measured variable from the process causes the regulator to make a different amount of change in its corrective action.

It will be remembered that the corrective action of the regulator is its output pressure. This pressure acts on the diaphragm of the valve, thus changing the effective valve port area which in turn affects the flow through the valve. Since the slope of the regulator's proportional band characteristic curve is constant and fixed for any given adjustment, it is then required that a valve be used, which will produce changes in flow through the piping associated with the process, which have, as near as possible, a constant flow-stroke relationship, in order to cooperate fully with the stroke-measurement ratio fixed by the proportional band setting of the regulator.

Closed-Loop Relationships.

In order to indicate more clearly the definite relationship between the component parts of the control loop, Fig. 4 is a re-arrangement of Fig. 3. When regulation is obtained all operation is confined to the line *CP* in the regulator and the process blocks. Proportional band settings may be made as B and B_1 in the regulator block and process changes may cause load variations as indicated by L and L_1 in the process block.

Referring still to Fig. 4, since our control circuit is a closed-loop, and since we are interested in reactions, the same curves are given, exhibiting not only the characteristics of the valve and line, but also those of the process and controller. For the controller a graph of output pressure versus temperature is shown. The output of the controller is transferred to the valve as the fractional stroke, sigma (σ). In fact this might be taken as the output pressure of the instrument in any units, say pounds per square inch, divided by its maximum value.

In turn, the ports of the valve change this fractional stroke into the effective opening ratio omega (Ω) of the valve, identified elsewhere as the ratio of the opening of the valve to the equivalent opening of the line. A typical curve or a graph of this ratio against stroke is given in the valve block of the diagram.

By the combination of this opening ratio and the flow properties of the line, sigma (σ) the stroke of the valve transforms omega (Ω) into phi (ϕ), the fraction of the maximum flow. This variable flow fraction phi (ϕ) reacts through the process to affect the temperature, or whatever variable the regulator may be handling. Thus our loop is completed back to the regulator. For that portion of the block diagram typifying the instrument, the slope of the curve is a result of the proportional band setting.

Importance of Valve Characteristic

Thus, it becomes quite apparent how it is most desirable, for the purpose of regulation, to obtain a valve characteristic which, when combined with the piping characteristics of an installation, produces flow changes resulting in the greatest possible constancy of slope for the over-all flow-stroke relationship. This is true particularly when conditions of total system pressure, line resistance or even valve size are changed. The instrument engineer will quickly realize the large number of process conditions which can result in such changes.

The discrepancy which exists between constancy of proportional band slopes in the regulator and the fact that some regulators do not have a uniform scale, is dealt with graphically by Figs. 5 and 6. It will be noted by inspection of Fig. 5 that the useable portion of a direct reading meter chart is a fairly close approximation to a straight line in that section of the scale.

The characteristics are ordinarily less definite for a temperature application. For the contribution of the vapor tension thermal system, Fig. 6 indicates that the outer section of the chart likewise approaches a straight line. That is to say, the proportional and characteristic for this section of the scale approaches linearity. Certain ranges show more departure, and others less, dependent upon the range, the filling medium and the instrument construction. These curves temper somewhat the strict assumption that, over the normal working range, the slope of the proportional band characteristic is substantially constant. However, the rationalization is seen to be reasonable.

THE VALVE AND THE LINE OF FLOW

In dealing technically with the subject of control valves, an engineer soon becomes impressed with the somewhat unexpected complexity of the relations involved. This complexity is due to the existence, even surrounding the valve alone, of a number of distinct variables. In general, when a control valve is being operated, practically nothing remains constant. The stroke of the valve is varying by virtue of the controller's operation upon it.

The flow through the valve varies —this being its purpose. Further, the pressures upstream and downstream, and in particular the pressure drop across the valve, are often changing, not only as the flow through the valve changes, but because of uncontrolled resistance in the line. Thus there are at least three variables to be considered, each of which has its particular effect on the others.

Nothing specific has been said, thus far, of the relation between the stroke of a valve and its opening area. While stroke directly affects area, in any given case, it is really the opening and not the stroke which determines the flow and drop phenomenon in the line. Thus it is logical, and of considerable aid in reasoning, to separate the general problem into two main parts. The general problem may be thought of as pertaining to the relationship which embraces flow and stroke, for this, in the typical case, is the resultant of all factors in this part of the control circuit.

Relation Between Opening and Stroke

In separating this all-inclusive relation into two parts, it works out best to consider first the relationship between opening and stroke. This will be seen to be a property of the valve as such, and is what is ordinarily referred to as the characteristic of the valve. Secondly, there is the relationship between flow and opening. This is the part which includes the line reactions and it is necessarily concerned with pressure drops.

The desired characteristic of a valve, considered as the relationship between its stroke and its effective opening area, may be mechanically embodied by a number of different means. Such characteristics may vary all the way from a simple linear relation, as in a poppet type of valve, to the most precise wide range exponential form. The most common methods by which characteristics are embodied include: (1) shaping of a plug inserted into a servicing ring, (2) cutting of specially shaped ports in a (stationary or movable) cylindrical "skirt," and (3) a combination of these two.

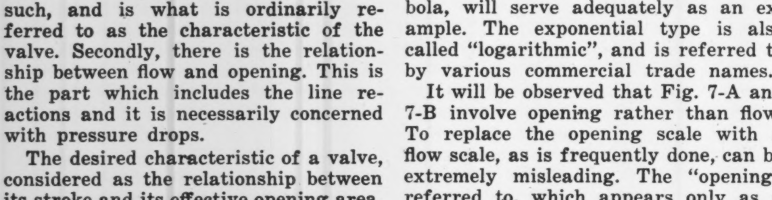

Fig. 7A (left) and 7B (right). Opening characteristic for three valve types plotted on rectangular and semi-logarithmic co-ordinates.

A control valve characteristic is generally exhibited quantitatively by plotting opening versus stroke. Such plotting has frequently been carried out on semi-logarithmic co-ordinates, with the stroke along the linear vertical axis, and opening along the horizontal logarithmic axis. The reason for this choice of co-ordinates has been that their use led to a simple curve, a line in fact, when a certain type of valve was considered.

This unorthodox procedure as to the choice of axes will be understood, when the frequently used "lift" is substituted for the word "stroke", whereas the more logical procedure would be to plot the area or *opening* vertically, since this is the dependent variable. Here we shall not restrict ourselves to any particular tradition, except that ordinary linear co-ordinates will be largely adhered to, as being best for showing the true character of the relations.

Typical Opening-Stroke Relations

The opening-stroke characteristics of the three widely used types of valves are shown in Figs. 7-A and 7-B, using the two systems of co-ordinates already mentioned. In each figure appear the characteristics of a linear, a V-port or "parabolic", and an exponential type of valve. There are many other types of parabolic characteristic, but the one shown, a mathematical parabola, will serve adequately as an example. The exponential type is also called "logarithmic", and is referred to by various commercial trade names.

It will be observed that Fig. 7-A and 7-B involve opening rather than flow. To replace the opening scale with a flow scale, as is frequently done, can be extremely misleading. The "opening" referred to, which appears only as a ratio or percentage, is an effective opening, and may be thought of as the opening area of an orifice having the same flow properties as the valve at the particular stroke concerned.

To be sure, if a valve is operated under a constant drop or pressure difference, the opening scale may be directly replaced by a flow scale, at least for most purposes. If such an assumption is made, however, in plotting the characteristics of a valve, it should always be explicitly stated. There is no need to enlarge upon the stroke-opening characteristics shown in these figures, for they are relatively familiar and also they speak for themselves.

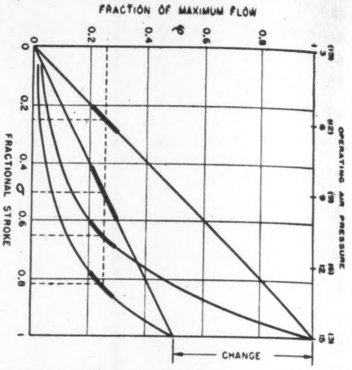

Fig. 8. Phenomena with constant pressure drop across the valve.

Effect of "Line Drop"

Among the more important properties, of the piping and apparatus present in the flow line with the control valve, is the one familiarly known as "line-drop". This property has a decided influence on the over-all flow-stroke performance of the valve as installed, and must be taken into account in any thorough analysis. Line-drop is merely the variable pressure drop, not through the valve but through the length of pipe and equipment, extending in both directions to the limits.

If the pressures at these limits, and hence also the total pressure drop across line and valve together are constant, then the valve-drop and the line-drop must add up to a fixed sum. These two drops are thus definitely related and must be considered together in their effect on the proper functioning of the valve. Since the line-drop must vary as the flow changes, so likewise will the drop across the valve.

To begin with, let us look at a case in which there is no linedrop, or in which the pressure drop across the valve has a constant value. Such a state might be due to a relatively large line size and to the absence of restrictions or restricting apparatus, or it might be brought about artificially, as by independent automatic control of the valve drop or of both upstream and downstream pressures.

In such a case, the flow will vary in direct proportion to the effective opening area* and hence, with a linear valve, in proportion to the valve stroke. The maximum flow obtainable will vary with valve size and with pressure drop. If the pressure drop is quartered, then on the assumption of square-law hydraulics the maximum flow will be halved.

Halving the valve size, in terms of the area of an equivalent orifice, will have a similar result on the maximum flow. Fig. 8 shows the flow-stroke characteristics obtained in this special

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*By definition, in fact, of "*effective opening*" area.

case. The straight lines are drawn for a linear opening-stroke characteristic of the valve; the others are for an exponential characteristic.

Effect of Valve Size

The two sets of curves, one reaching the assumed maximum flow and the other attaining only one-half of that flow, show the effect of halving (or doubling) the valve size. They show, equally well, the effect of quartering (or quadrupling) the pressure drop. Suppose we are interested in obtaining a particular flow, such as say one-quarter of the assumed maximum.

This flow is represented in Fig. 8 by the horizontal dotted line. To maintain this flow with the linear valve, as conditions change from one to the other of the two considered, the fractional stroke position must change from 0.25 to 0.50. This might correspond to a change in controller output pressure from 6 to 9 psi.

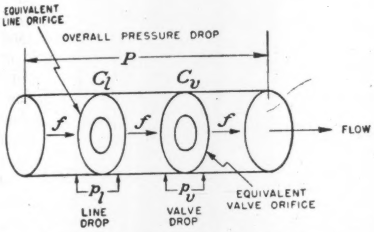

Fig. 9. Equivalent structure for typical flow lines.

With the exponential valve, the two stroke positions involved are 0.65 and 0.82, with corresponding controller output pressure values. The important thing, however, is not these values but rather the ratio of change of flow with respect to change of stroke; the slope of the curves, that is, at the appropriate points.

This slope, or ratio, determines the operation of the control installation in the same way as does the proportional band of the controller, and is equally influential. It will be seen that, for a given required flow the slope of flow-stroke sensitivity is altered by a change in conditions when the linear valve is used, but is left unchanged with the exponential characteristic. The truth of the statement does not depend on the flow value chosen.

This is all very well, but the assumption of a constant valve drop on which it is based is not always justified.

Equivalent Orifice Areas

The idea of an equivalent orifice area, to represent the conditions of a valve being operated, may apply also to the restrictions supplied by the line and its equipment. For any line, exclusive of the valve, there may be set up an equivalent orifice which duplicates its resistance to flow. The effective opening of the valve, a variable, may be measured and expressed in terms of the area of the equivalent line orifice, generally a constant.

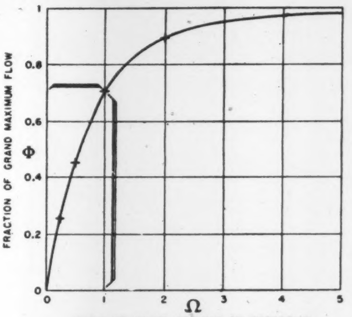

Fig. 10. Relation between fractional opening and fractional flow.

Such a measure, the ratio, that is, between the opening of the valve and the equivalent opening of the line, is the purely numerical variable Ω defined in the Appendix. It has been used as the horizontal co-ordinate in Figs. 10 and 11, in which appear the flow and drop relationships in the system.

If this opening ratio is zero, either the valve is shut or there is no line restriction or line drop; if unity, it refers to a valve opening equal to the equivalent opening of the line. If the valve is removed from the line entirely, giving no valve restriction, then the opening ratio is infinite.

The system under consideration is that of two orifices in series in an appropriately large line, there being constant pressure drop across the whole affair. This concept is indicated schematically by Fig. 9.

As the area of the orifice representing the valve opening varies, from zero to many times that of the orifice representing the line, the flow (f) through both orifices varies from zero to a value approaching the limiting maximum flow (F) obtained if the value were removed. The form of the relationship is shown in Fig. 10, which thus provides a general description of the combined effect of the line drop and valve size on the opening-flow characteristic.

Suppose, for example, that the valve size were such as to permit a maximum opening equal to the equivalent line opening. Such a valve would provide, at most, a little under 0.71 of the maximum obtainable flow. All operation would be restricted to the bracketed portion of Fig. 10.

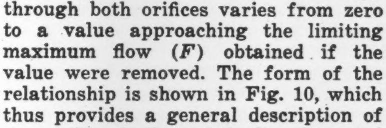

Fig. 11. Relation between fractional valve drop and fractional opening.

Still employing the analogy of two orifices in series, we may consider the pressure drop across the "valve orifice" as the valve is opened. With the valve closed, the flow is zero and hence the line drop is zero. But the drop across the valve is maximum. As the valve is opened, the pressure drop across it decreases from this maximum according to the curve shown in Fig. 11, the remaining drop being absorbed by the line and equipment as the flow goes up. Flow and valve drop are thus inseparably related, and Figs. 10 and 11 show how. A few cases may be tabulated as given in Table I, for maximum conditions:

TABLE I.

Case Number	*Max. Valve Opening as % of Equivalent Line Opening*	*Valve Drop as % Total Drop at Maximum Valve Opening*	*Flow at Maximum Opening as % of Maximum Flow with no Valve*
1	25	94	25
2	50	80	45
3	100	50	71
4	200	20	89
5	400	6	97

To show the relationship which must exist between the fractional drop across a valve and the fraction of maximum flow passing through it, the curve shown in Fig. 12 is included, indicating a point often overlooked; i.e., the pressure drop not absorbed by the valve must, of necessity, be taken up by the line and equipment. This is an indisputable fact when we examine Fig. 12.

At the risk of appearing bent on teaching, one ventures to suggest a practical point here; that is, the designer cannot specify, on bills of material and other such construction paper, the pressure drop across a control valve without benefit of exact line drop data. The latter is often estimated empirically and to that extent is questionable. This point incidentally is one of the most compelling arguments in favor of wide range characteristics.

STROKE TO FLOW RELATION

In most cases the properties of the line are fixed, whereas the size and type of valve employed are subject to selection. Considering first a linear valve characteristic, the foregoing informa-

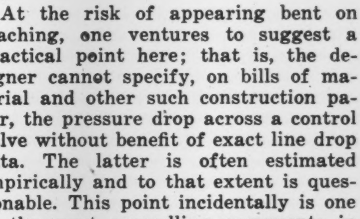

Fig. 12. Relation between fractional flow and fractional valve drop.

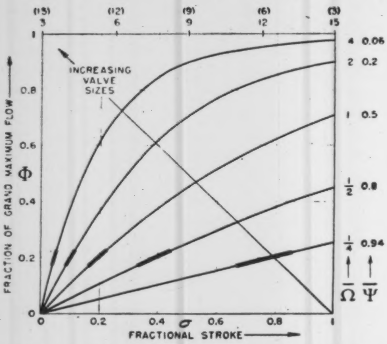

Fig. 13. Effect of changing valve size on the stroke-flow characteristic of a linear valve with line drop.

tion allows us to show the flow response obtained when different valve sizes are used in a given line. The flow-stroke curves under these conditions are plotted in Fig. 13 for linear valves, each curve being drawn for a different valve size.

The latter is important in relation to the properties of the line. It is expressible in terms of the maximum opening ratio as described above. Thus the lowest curve of the figure is drawn for a valve which opens up to an effective area which is only one-fourth that of the equivalent line orifice. The pressure drop across the valve when wide open is 94 percent of the total drop available, as may be seen from Fig. 13.

The flow rises along a rather straight path, as the valve is opened, to a highest value of about 25 percent of the maximum available with valve omitted. (It will be remembered that we are dealing with a valve having a linear characteristic.) This may be called an example of low line drop, even though the line has not been changed, for neither valve size nor line drop is significant, one without the other.

With a valve sixteen times as large, in effective area, the topmost curve of Fig. 13 is obtained. The valve pressure drop when wide open is only 6 percent of the total across line and valve together, and the flow under these conditions will be seen to attain 97 percent of the available maximum. The familiar effect on line drop or of large valve sizes is shown in the shape of this flow curve; flow increases rapidly as the valve is first opened and levels off to give very little change through the last half of the stroke.

For intermediate valve sizes the results are shown by the other curves of Fig. 13. As larger valves are used, as would be expected, greater portions of the maximum flow are obtainable, but along with this gain comes an increase in the distortion due to "line drop". The fractional drop across the valve at maximum flow is tabulated on the curves.

Importance to Control.

The flow-stroke slope has an importance to control which has been mentioned above. For any given desired flow—say 20 percent of the maximum—this slope is observed to vary markedly as one passes from one curve to another in Fig. 13. Furthermore, the variation of the flow-stroke slope along the curves themselves is very different for each curve. This means, for example, that the properties which are important to control will vary widely, not only for different flow conditions, but also for differences in other factors, such as the size of valve chosen. Since the latter choice is important from an economic viewpoint, conflicting requirements may readily arise with this class of valve.

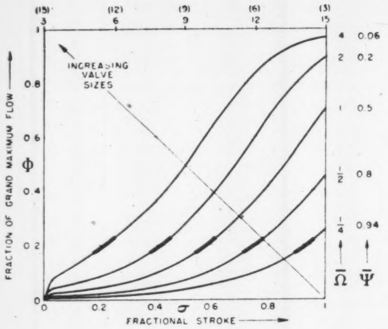

Fig. 14. Same as Fig. 13, except for exponential type valve.

This state of affairs is invariably altered when an exponential valve characteristic is considered. Fig. 14 contains the same information as does Fig. 13 except with reference to an exponential rather than a linear valve. Two modifications are immediately evident. First, the distortion due to large line-drop effects is definitely resisted. Second, the flow-stroke sensitivity, the slope of the curve at any flow, say 20 percent of the maximum, is made substantially independent of such conditions as valve size. These are unique mathematical properties of this type of valve characteristic.

While changes in valve size are initially important, in process work, a somewhat more persistent failing is that of total pressure fluctuations,* during operation.

By similar methods and the use of information already employed, it may be demonstrated that here again the exponential valve possesses inherent properties of value to control.

Effects of Low Line Drop.

Before departing from the subject of valve size, however, a point will be of interest concerning installations involving comparatively low line drop conditions: that is to say, for relatively low values of maximum opening ratio Ω and relatively high values of minimum fractional valve pressure drop $\overline{\Psi}$. Inspection of the lowest curve of Fig. 13 indicates very little change in slope.

These conditions are typical of a large proportion of the needle valve installations. They are fairly common in production work and are often encountered in pilot plant and semi-plant scale installations. In the latter, line sizes are often relatively large since construction work is more readily carried out with standard line sizes.

Thus in half-inch lines, and larger, and without restricting equipment, it is not uncommon for valves to approach nominal sizes, as far as port area is concerned, of 1/32 inch and smaller. It is very nearly impossible for an installation of these physical dimensions to approach the condition of high line drop. This is offered as evidence of the fact that the need for precise characteristics in such valves, when there is good terminal pressure stability, is not as important for combating line drop as valve installations of relatively larger size.

Effect of System Pressure Drop.

One may also show, again graphically, the relation which exists between flow and stroke when the pressure drop across the whole system is altered. For the purpose of comparison, Fig. 15 shows this relationship for a linear valve. This time, instead of representing the fraction ϕ of the maximum flow F, available in each case, the vertical axis indicates the fraction ϕ_n of the grand maximum flow F_n, available under a *normal* total pressure drop.

An attempt to show the conditions available for all values of maximum

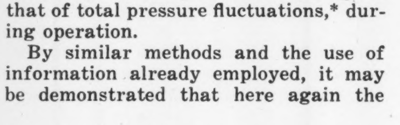

Fig. 15. The effect of changing total pressure; linear valve with line drop.

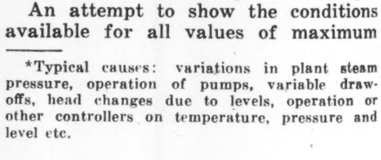

Fig. 16. Same as Fig. 15, but for exponential valve.

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*Typical causes: variations in plant steam pressure, operation of pumps, variable draw-offs, head changes due to levels, operation or other controllers on temperature, pressure and level etc.

opening ratio $\overline{\Omega}$ would obscure the purpose of such a graph. Accordingly, a valve having a maximum opening ratio $\overline{\Omega}$ of 2 and a minimum pressure drop ratio $\overline{\Psi}$ of 0.2 has been chosen as typical. Note that in this case these values remain fixed while the pressure on the system is changed. This type of alteration is distinguished from the sort shown in Figs. 13 and 14 above.

In that case the total pressure conditions were fixed and the effective valve size was varied—whereby the maximum opening ratio $\overline{\Omega}$ and the minimum pressure drop $\overline{\Psi}$ were modified by variations in the valve coefficient. The ordinate ϕ_n of the new graph is a modified form of the fractional flow ϕ which makes use of the normal total pressure condition mentioned above.

This new flow variable is chosen so that vertical increments represent the same actual flow variations for all curves. For the curves of Fig. 15 a variation in the total pressure has been assumed from 25 percent above the chosen norm to 95 percent below it. The flow-stroke curves clearly indicate what is to be expected when line drop is involved and when dealing with a linear valve. The lowest curve indicates that only about 23 percent of the normal maximum flow may be obtained when the total system pressure is reduced by 95 percent.

As the total pressure increases the attainable flow likewise rises until, at a value 25 percent above the norm, the maximum flow has increased some 6 percent above the maximum for the norm. The line drop distortion of the curves persists as the pressure drop is changed; but, more significant, as we go from curve to curve for any given flow, there is a notable variety in the all important slope or flow-stroke sensitivity of the curves.

Comparison of Linear and Exponential Valves.

If, for the same conditions prevailing for Fig. 15, we change to the exponential type valve, there is immediately apparent a conspicuous change in the effect of line drop. Fig. 16 shows us that the slope of the curves remain more nearly constant over a wider change in the flow fraction. Constancy of slope is preserved over a considerable portion of the total pressure drop change from maximum to minimum.

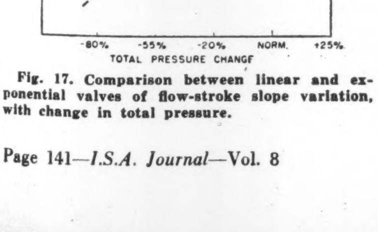

Fig. 17. Comparison between linear and exponential valves of flow-stroke slope variation, with change in total pressure.

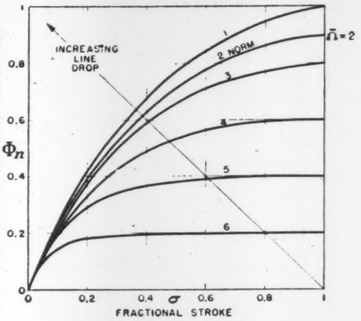

Fig. 18. Effect of changing line restriction for linear valves. (Numbers of curves correspond to tabulation in Appendix.)

To show the relative variation in slope of the curves from Figs. 15 and 16, at a typical given flow, such as 30 percent, as we change the terminal pressures or the total pressure drop, Fig. 17 has been included. Whereas the relative variation of slopes for changes of valve size is immediately apparent when Figs. 13 and 14 are inspected, Fig. 17 indicates graphically that a similar, though less marked, condition holds as the total system pressure drop is altered. The importance of the valve characteristic to stable control is again evident.

Effect of Changes in Line Characteristics Alone.

While the change indicated by Figs. 15 and 16 is that of complete system pressure drop, by similar considerations the effect of changes in line characteristics alone can be shown to be rather similar thereto. In this case, the total pressure drop is again constant, as was assumed in Figs. 13 and 14, but the maximum opening ratio is varied, in this instance, by changing the equivalent line orifice, while the valve size remains fixed.

In practice, this set of circumstances would be encountered when a manually operated valve, or other restricting device in series with the control valve, is repositioned. As was the case for Figs. 15 and 16, it is again necessary to assume a norm condition in order to show the effects of both an increase and a decrease in the resistance to flow, causing line drop. The same norm is retained, represented by a maximum opening ratio $\overline{\Omega}$ of 2.

With Fig. 18, line drop effects are again apparent in the warping of the flow-stroke curves, for a linear valve, to varying degrees depending on the maximum opening ratio. The resulting slope variations show this valve to be of questionable value with proportional controller types. As would be expected, the maximum attainable flow in each case varies with the line restriction, increasing as an increase in the line coefficient decreases the opening ratio $\overline{\Omega}$.

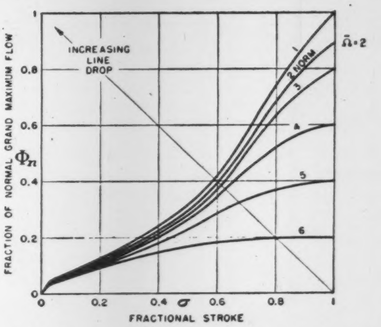

Fig. 19. Same as Fig. 18, but for exponential valve.

Though the curves are roughly similar to those of Figs. 13 and 15, the precise form varies somewhat. The difference is mainly evident for the greatest line restrictions. This comes about because any given fractional opening will allow a larger proportion of the total attainable flow as the line restriction increases. The several curves are numbered to correspond with a tabulation of values in the appendix.

Fig. 19 is drawn for the same conditions as is Fig. 18, but with the linear valve replaced by one of exponential characteristics. Evidence is found again, in Fig. 19, that the use of the exponential characteristic tends to neutralize and nullify the deformation of the flow-stroke properties. The improved uniformity of slope, and the resistance to change of characteristic over wide ranges, in spite of serious and varying line restrictions, will be evident to the reader without further ado.

Other Considerations in Application

One should not assume that the only requisite of a throttling type control valve is the eradication of line drop effects. Fig. 20 indicates the opening-stroke characteristic of a valve which does precisely this for one particular set of circumstances. The special case considered is one in which the maximum valve opening is equal to the equivalent line opening. Much of our attention has been devoted to the effects of line drop and how they may be made harmless by the choice of valve characteristics. Factors other than line drop must be considered, among these being

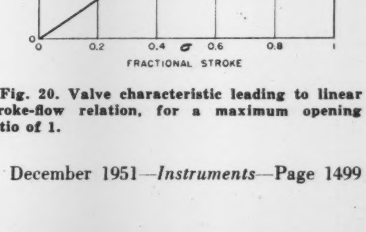

Fig. 20. Valve characteristic leading to linear stroke-flow relation, for a maximum opening ratio of 1.

the practical problems of changing flow conditions, the sizing of the valves, etc.

The equation for the valve characteristic curve of Fig. 20 is given as Equation 25a in the appendix for the special case in which the maximum opening ratio $\overline{\Omega}$ is unity. It is to be understood that the case of other maximum opening ratio values could be met by a somewhat different valve characteristic curve. Though considered here only theoretically, such valves might not be as impractical as casual consideration might lead one to believe, especially where a linear stroke-flow relation is essential and where the total pressure conditions are reliably maintained. By the use of suitable pressure gauges, in fact, installations could be made wherein the line restriction could be adjustable, by a manually operated series control valve, to that value for which the valve was designed.

For an idea of the nature of this valve characteristic, the curve of Fig. 20 may be compared to those of Fig. 7A. However a linear stroke-flow characteristic is obtained, by this means, only for one maximum opening ratio, and, of course, for a constant total pressure drop. Similar reasoning would lead to other valve characteristics to give, for example, parabolic or exponential flow stroke relations in the presence of any fixed line restriction.

CONCLUSION

In conclusion, it may be pointed out that the exponential valve does much more than simply produce equal percentage change in effective opening area for equal increments of stroke. Uncontrolled pressure drop, in the line of flow, is inseparably related to the pressure drop across the control valve with consequent damaging effects on automatic regulation when linear valves are used. The exponential type valve combats the ill effects of this uncontrolled line drop for numerous installations, and also meets well the threat of variation in the terminal pressure difference. Due to its versatility, the exponential type valve effectively relieves the necessity of precision sizing to obtain satisfactory automatic control. The wide range of the exponential valve meets many economic requirements for both capacity and control owing to its high retention of a desirable flow-stroke characteristic for the great majority of cases, despite all interfering circumstances.

There is much evidence that the exponential type valve is nearest the ideal for a large, middle ground, group of applications. This is particularly true of the control of temperature and pressure, and for typical direct flow control installations with normally fixed index settings. For many applications it will be found to be a compromise, in much the same way that the choice of band, with a proportional controller, is a compromise. For certain special applications it is most assuredly wrong.

By a study of Fig. 7A, for example, showing the characteristic of the V-port or the conventional parabolic valve in conjunction with those of the linear and exponential types, it is to be seen clearly that this characteristic is a wanting intermediate which does not possess fully the properties of either of the other types. Little would be gained by applying the V-port valve to an application of on-off control, classically requiring a poppet type valve.

On the other hand, for a continuous, throttling application, great care would have to be exercised in choosing the valve size. The application would be greatly restricted as to load, as far as comparable performance is concerned, and even within its zone of acceptable performance for certain conditions, uncontrolled changes in pressure or line drop would doubtless be noticeable from the results obtained.

The simple basic ideas upon which the results here given were founded, apply to most valve installations employed today. Any such results, however, are only as valid as the assumptions which are made in the beginning. Thus, to reiterate, the paper deals entirely with the case of square-law flow. Furthermore, an incompressible fluid has been assumed. While the results would be complicated and altered in the more general cases, the same broad conclusions would be found to hold almost universally. The use of dimension ratios for the significant variables and properties of the system, has aided partly in this regard.

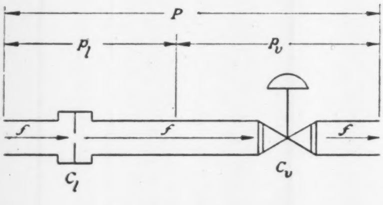

Fig. 21. Basic flow network, showing variables.

Omission is acknowledged of some important cases in the application of control valves. Thus, the effect of a manual by-pass valve has not been shown. Such valves, however, should be closed during operation except as an emergency measure. More noteworthily, the several cases of branched networks where the significant flow is through a part of the network other than that in which the control valve is located, have not been included in this paper.

ACKNOWLEDGEMENT

The authors acknowledge their indebtedness, for suggestions and earlier contributions, to Messrs. R. D. Webb and C. E. Mason. Valuable additional assistance has also been received from L. K. Spink, P. R. Pearson, G. I. Bilyeu, W. H. Howe, R. A. Bristol and other colleagues and associates.

APPENDIX

The flow system under consideration, assumed to be typical of most control installations, is shown diagrammatically in Fig. 21. The analogy between this system and that of Fig. 9 will be clear. The duct itself is assumed large enough that negligible pressure drop is caused thereby, even at the maximum flow. Of the two flow restrictions assumed in the duct, one represents, and is equivalent in flow characteristics to, a practical-sized line with equipment and fittings. The other represents and is equivalent to whatever valve is under consideration.

For the purposes of this analysis, the following terminology is applied. Greek letters are used throughout for dimensionless ratios. Any consistent set of units may be employed.

A_l	Effective orifice area for the line.
A_v	Effective orifice area for the valve.
C_l	Discharge coefficient for the line.
C_v	Discharge coefficient for the valve.
$\overline{C}_v$	Discharge coefficient of the valve when wide open (when $\sigma = 1$).
f	Flow through the valve and line at any moment.
f	Maximum flow with the valve wide open.
F	Grand maximum flow with control valve removed.
F_n	Grand maximum flow for an assumed normal condition.
p_l	Pressure drop across the line alone.
p_v	Pressure drop across the valve alone.
P	Pressure drop across the entire system.
ρ	Rangeability.
σ	Fractional stroke ($0 \leq \sigma \leq 1$).
ϕ	Fraction of maximum flow ($f/\overline{f}$).
Φ	Fraction in effect of grand maximum flow (f/F).
$\overline{\Phi}$	Maximum fraction of grand maximum flow ($\overline{f}/F$).
ϕ_n	Fraction of normal grand maximum flow (f/F_n).
Ψ	Fraction of total pressure drop in effect across the valve.
$\overline{\Psi}$	Fraction of total pressure drop across the valve when wide open.
ω	Fractional valve opening ($C_v/\overline{C}_v$, or $\Omega/\overline{\Omega}$), ($0 \leq \omega \leq 1$).
Ω	Opening ratio ($\overline{C}_v/C_l$).
$\overline{\Omega}$	Maximum opening ratio ($\overline{C}_v/C_l$).

From the diagram several relations will be apparent. Thus, by definition, for the pressure drops,

$$P = p_v + p_l \qquad [1]$$

Now, since we are assuming square-law flow,

$$f = C_l\sqrt{p_l} = C_v\sqrt{p_v} \qquad [2]$$

where C_l and C_v are proportional respectively to the equivalent orifice areas A_l and A_v. Directly from Equation 2 we have

$$p_l = \frac{f^2}{C_l^{\,2}} \quad \text{and} \quad p_v = \frac{f^2}{C_v^{\,2}} \qquad [3],\ [4]$$

Incorporation of these relations in Equation 1 gives

$$P = f^2\left[\frac{1}{C_l^2} + \frac{1}{C_v^2}\right] \qquad [5]$$

or, solving for the flow,

$$f = \sqrt{\frac{1}{\frac{1}{C_l^2} + \frac{1}{C_v^2}}}\sqrt{P} \qquad [6]$$

where the first square-root expression on the right is the equivalent coefficient for the whole line.

When the valve restriction is removed C_v becomes infinite and the flow f attains its grand maximum value F. Equation 6 becomes then

$$F = C_l\sqrt{P} \qquad [7]$$

To find the fractional flow we divide Equation 6 by Equation 7 obtaining

$$\frac{f}{F} = \sqrt{\frac{1}{1 + \frac{C_l^2}{C_v^2}}} \qquad [8]$$

or, by the definitions of Φ and Ω,

$$\phi = \sqrt{\frac{1}{1 + \frac{1}{\Omega^2}}} \qquad [9]$$

The inverse equation is

$$\Omega = \sqrt{\frac{1}{\frac{1}{\phi^2} - 1}} \qquad [9a]$$

This relation between the flow fraction and the opening ratio is plotted as the curve of Fig. 10.

For the pressure ratio, Equations 4 and 5 gives us

$$\frac{P_v}{P} = \frac{1}{1 + \frac{C_v^2}{C_l^2}} \qquad [10]$$

or, by the definitions of Ψ and Ω,

$$\psi = \frac{1}{1 + \Omega^2} \qquad [11]$$

The inverse equation is

$$\Omega = \sqrt{\frac{1}{\psi} - 1} \qquad [11a]$$

which is the relationship between the valve drop fraction and the opening ratio plotted as the curve of Fig. 11. By subtracting both sides of Equation 11 from unity, we find

$$1 - \psi = 1 - \frac{1}{1 + \Omega^2} = \frac{1}{1 + \frac{1}{\Omega^2}} \qquad [12]$$

It is now seen directly, by comparing Equations 9 and 12, that

$$\phi = \sqrt{1 - \psi} \qquad [13]$$

Again, the inverse relationship is

$$\psi = 1 - \phi^2 \qquad [13a]$$

where $(1 - \Psi)$ will be recognized as the fractional pressure drop in the line and equipment. This equation embodies the necessary relationship which exists between the flow fraction and the valve drop fraction, and provides the curve for Fig. 12.

Before turning to valve characteristics, we shall give the dimensionless equivalent for the classical "$f = C\sqrt{p}$" relationship, but applying to the whole line. By division among Equations 2 and 7 and by the definition of Φ, Ω, Ψ, we have, quite generally,

$$\phi = \Omega\sqrt{\psi} \qquad [14]$$

By the *valve characteristic* is meant the behavior of the coefficient C_v, or of the effective orifice area A_v, as the fractional stroke σ is varied from zero to one. Employing ratios, we may plot $A_v/\overline{A}_v$, $C_v/\overline{C}_v$, or $\Omega/\overline{\Omega}$, as the fractional valve opening ω; the bars referring to the "wide-open" condition. For any valve whatsoever, $\omega = \omega(\sigma)$. For a linear type valve ω is directly proportional to σ; in fact

$$\omega = \sigma \qquad [15]$$

For the parabolic type ω is linearly related to the square of σ. Taking the fractional opening at "zero" stroke at $1/\rho$, and requiring that $\omega(1) = 1$, we may write

$$\omega = 1/\rho + (1 - 1/\rho)\,\sigma^2 \qquad [16]$$

For the exponential type ω is proportional exponentially to the stroke σ, so that

$$\omega = \rho^{(\sigma - 1)} \qquad [17]$$

where again $\omega(0) = 1/\rho$ and $\omega(1) = 1$.

Equations 15, 16, and 17 supply the curves for Figs. 7A and 7B, ρ being taken as 50 for the exponential valve and 12 for the V-port. We note the realistic proviso embodied in the plots, that neither can have an "initial" flow greater than a linear type, for a given stroke and seat diameter.

Equations 9 and 15 provide the relation between stroke σ and flow fraction Φ for a linear valve, since by definition $\Omega = \overline{\Omega}\omega$. We find thus,

$$\phi = \sqrt{\frac{1}{\frac{1}{\overline{\Omega}^2\,\sigma^2} + 1}} \qquad [18]$$

where $\overline{\Omega}$ is the maximum opening ratio (for wide-open valve). Fig. 13 shows the relation, for values of $\overline{\Omega}$ of 4, 2, 1, ½, ¼, corresponding to different valve sizes in a given line.

Similarly from Equations 9 and 17, we have, for the exponential valve,

$$\phi = \sqrt{\frac{1}{\frac{1}{\overline{\Omega}^2\,(\rho^{\sigma} - 1)^2} + 1}} \qquad [19]$$

The curves of Fig. 14 are plotted from this equation for the same values of the maximum opening ratio $\overline{\Omega}$.

The curves of Figs. 15 and 16 result from assuming a variation of the total pressure about a norm, applied to a system with a valve having a fixed maximum opening ratio $\overline{\Omega}$ of 2.0. Since F varies from case to case here we plot Φ_n, which is merely f/F_n: the actual flow divided by the fixed normal grand maximum. Since $F/F_n = P/P_n$, and by definition $\Phi_n = (F/F_n)\Phi$, we have for the linear valve, by Equation 18,

$$\phi_n = \sqrt{\frac{P}{P_n}}\sqrt{\frac{1}{\frac{1}{\overline{\Omega}^2\,\sigma^2} + 1}} \qquad [20]$$

which is plotted in Fig. 16. For the exponential valve, by Equation 19,

$$\phi_n = \sqrt{\frac{P}{P_n}}\sqrt{\frac{1}{\frac{1}{\overline{\Omega}^2\,(\rho^{\sigma-1})^2} + 1}} \qquad [21]$$

It is assumed in both figures that $\overline{\Omega}$ is 2.0, a typical value. For the norm curve $P = P_n$, in both instances. For the other five cases P was taken to be 1.25 P_n, 0.80 P_n, 0.45 P_n, 0.20 P_n and 0.05 P_n.

For Figs. 18 and 19 it is assumed that only the line restriction is altered, so that again the grand maximum flow is not constant. Thus we again plot ϕ_n in terms of F_n for the norm, but in this case the total pressure is constant. F/F_n in this case is simply C_l/C_{ln}, the assumed normal line coefficient being C_{ln}. Note further that $\overline{\Omega}$ will change in each case, being $\overline{C}_v/C_l$, even though $\overline{C}_v$ is fixed. In Fig. 18, for the linear valve characteristic, we have plotted

$$\phi_n = \frac{C_l}{C_{ln}}\sqrt{\frac{1}{\frac{1}{\overline{\Omega}^2\,\sigma^2} + 1}} \qquad [22]$$

and for the exponential valve, in Fig. 19.

$$\phi_n = \frac{C_l}{C_{ln}}\sqrt{\frac{1}{\frac{1}{\overline{\Omega}^2\,(\rho^{\sigma-1})^2} + 1}} \qquad [23]$$

A normal maximum opening ratio of 2.0 has been taken, and curves are given in each figure for the following values:

Curve		C_l/C_{ln}	$\overline{\Omega}$
1		100/89.6	2x0.896
2	(Norm)	1	2
3		80/89.6	2x(89.6/80)
4		60/89.6	2x(89.6/60)
5		40/89.6	2x(89.6/40)
6		20/89.6	2x(89.6/20)

To obtain (if desired) a valve characteristic giving a linear stroke flow relation in spite of line drop, we begin with the mathematical requirement

$$\varphi = \phi/\overline{\phi} = \sigma \qquad [24]$$

whence:

$$\sigma = \sqrt{\frac{1 + \frac{1}{\overline{\Omega}^2}}{1 + \frac{1}{\Omega^2}}} = \sqrt{\frac{1 + \overline{\Omega}^2}{\frac{1}{\omega^2} + \overline{\Omega}^2}}$$

Consequently, in general, the characteristics must be

$$\omega = 1 \Big/ \sqrt{\frac{1 + \overline{\Omega}^2}{\sigma^2} - \overline{\Omega}^2} \qquad [25]$$

or for a choice of unity for $\overline{\Omega}$, as plotted in Fig. 20,

$$\omega = \sqrt{\frac{1}{\frac{2}{\sigma^2} - 1}} \qquad [25a]$$

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J. L. Lopez P. O. Box 203, c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I. Tel. 2087.
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Jan. 4, Electric Bldg., Georgia Power Co.

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Jan. 7. Subject: Precision Measurement by Use of Lightwaves. Speaker: Adam Gabriel, Acme Scientific Co. Sponsored by Committee on Inspection and Gaging.
Feb. 4, Subject: Research vs. Industrial Instrumentation. Sponsored by Committee on Research Development.

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A. H. Staud, 1004 Michelson Lab., USNOTS. China Lake, Calif. Tel: 77882
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First Tuesday, Meeting at 7:30 P.M., U. of Kansas City, Science Bldg., Rm. 106.
January 8, Subject. Refinery Process Instrumentation. Speaker: David M. Boyd, Jr., Universal Oil Products Co., Chicago, Ill.
Feb. 5, Subject: Electronic Instrumentation. Speaker: Nelson Gildersleeve, General Electric Co.

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Jan. 28. Subject: Instrumentation Problems on the Aramco Oil Pipe Line. Speaker: Fred Rich. A color film will be shown of the construction of this line in Saudi Arabia.
Feb. 7-8, Fifth Annual Regional Conference. Subject: Power Plant Instrumentation.

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Jan. 8, Subject: Electric Combustion Control. Speaker: Orvil Riggs, The Hays Corp.
Feb. 12, Subject: Basic Television Receivers. Speaker: Joe Rudman, United States Steel Corp.

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Dec. 19, Subject: How Instruments Speed Fact Finding for the Philadelphia Gas Co. Street Division. Speaker: R. D. Holcombe.

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W. C. Langerman, Fisher Scientific Co., 711 Forbes St., Pittsburgh 19, Pa. Tel. Express 1-1330.
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Jan. 22. Subject: Measurement & Control of Pressure. Speaker from The Bristol Co.
Feb. 26, Subject: Measurement and Control of Temperature. Speaker: from Brown Instrument Co.

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Feb. 6, Subject: Electronic Instrumentation. Speaker: Nelson Gildersleeve, GE.

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Continued on page 1504

WILMINGTON

J. E. Charsha, Jr., Hammel-Dahl Co., 1000 Washington St., Wilmington 11, Del. Tel: 2-6694

Third Tuesday, Meeting at 8:00 P.M. Harlan Public School, Wilm.

ISA National Office Moves

The national office of the ISA will move about December 20th and members should address all future correspondence on society matters to 1319 Allegheny Ave., Pittsburgh 33, Pa.

Pigott—1952 ASME President

"Reg" J. S. Pigott, director of the engineering division of Gulf Research and Development Company has been elected president of the American Society of Mechanical Engineers for 1952. He is a past-president of the Society of Automotive Engineers, and was the first president of the American Society for Measurement and Control, now the Pittsburgh Section of ISA. Pigott was president of ISA in 1950.

Robert W. Hague

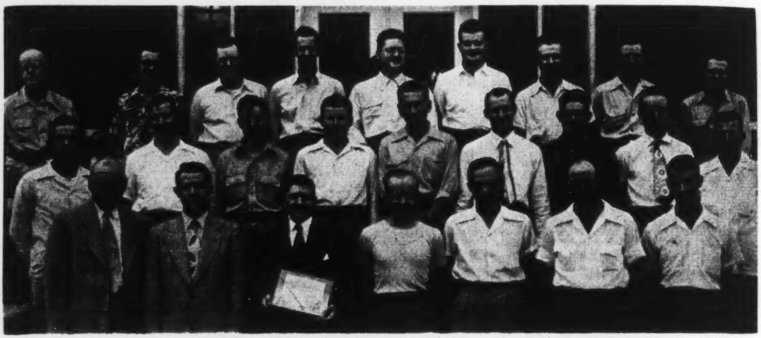
It is with deep regret that the Tennessee Section announces the death on October 20, 1951 of one of its members, Robert W. Hague. Mr. Hague joined the Tennessee Section in March 1948.

Safety Award for Instrument Department

In recognition of more than 700,000 manhours without an accident causing loss of time from the job, the Mid-Continent Petroleum Corp. instrument department recently was awarded the Joseph A. Holmes Association Certificate of Honor, issued by the U. S. Bureau of Mines, and the American Petroleum Institute Accident Prevention Award.

The instrument department, established July 16, 1919, with four men, has kept pace with the modernization and expansion of the Refinery until today there are 27 men in the department supervised by R. G. Huggins and his assistant, Ray E. Herring.

R. G. Huggins, who is a past president and a director of the Tulsa section, and Ray Herring, vice president in charge of membership of the Tulsa section, presented the safety record to the management of the Company in such a way that the Company gave an ISA membership to all members of the instrument department.



Pictured above are members of the department: Front row (left to right)—R. G. Huggins, J. M. Hyde, J. E. Sechrest, J. P. Provine, R. E. Bruton, J. B. Nicodemus, and R. A. Morrison.

Second row (left to right)—A. J. Warren, G. L. Farrimond, G. M. Hoyer, D. W. Melton, K. H. Thompson, P. S. Stamps, R. L. Renfro, H. L. Wilson, and Guy L. Weir.

Back row (left to right)—U. E. Howard, F. C. Baker, C. Y. Bayless, W. E. Byfield, R. E. Herring, R. L. Moore, W. E. Persing, R. E. Owens, and D. A. Egbert.

Not in the picture are O. C. Anderson and T. P. London.

Philadelphia Section Symposium on Boiler Instrumentation

On November 15th, Mr. F. S. Becker, President of the Philadelphia Section welcomed about 300 engineers who assembled in the Garden Room of the Bellevue-Stratford Hotel to hear the papers and discussions on boiler instrumentation. The program consisted of 2 papers at both the morning and afternoon sessions and a single paper in the evening:

MORNING

Introductory Remarks—Technical Chairman, A. W. Thorson, Supervising Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

"Design of Instrumentation and Control in a Modern Power Plant"—T. Y. Mullen, Engineering Department, Gilbert Associates, Inc.

Discussion by Henry Tanner, Bailey Meter Co., W. Bennett, Penn Industrial Instrument Co.; L. Walters, Republic Flow Meters; and P. H. Putnam, Fluid Controls Co.

"What the Boiler Designer Expects of Instrumentation"—H. C. Mittendorf, Chief Electrical Engineer in Charge of Control Design, Combustion Engineering-Superheater, Inc.

Discussion by James H. Harlow, Philadelphia Electric Co., W. L. Paulson, Bailey Meter Co.; and V. S. Renton, Public Service Co., New Jersey.

AFTERNOON

"Types of Combustion Control—Superheat and Reheat Controls"—E. D. Scutt, in Charge of Steam Power Section, Leeds & Northrup Company.

Discussion by W. Edwards, Combustion Engineering-Superheater, New York; and E. Durham, Babcock & Wilcox Co., New York.

"Modern Feed Water Control"—C. H. Barnard, Application Engineer, Bailey Meter Company.

Discussion by Mr. M. D. Engle, Pennsylvania Power & Light Co., Allentown, Pa.; Mr. S. L. Morse, Babcock & Wilcox Co., District Service Engineer; James H. Harlow, Philadelphia Electric Co.; and Paul Jorgensen, United States Naval Boiler and Turbine Laboratory.

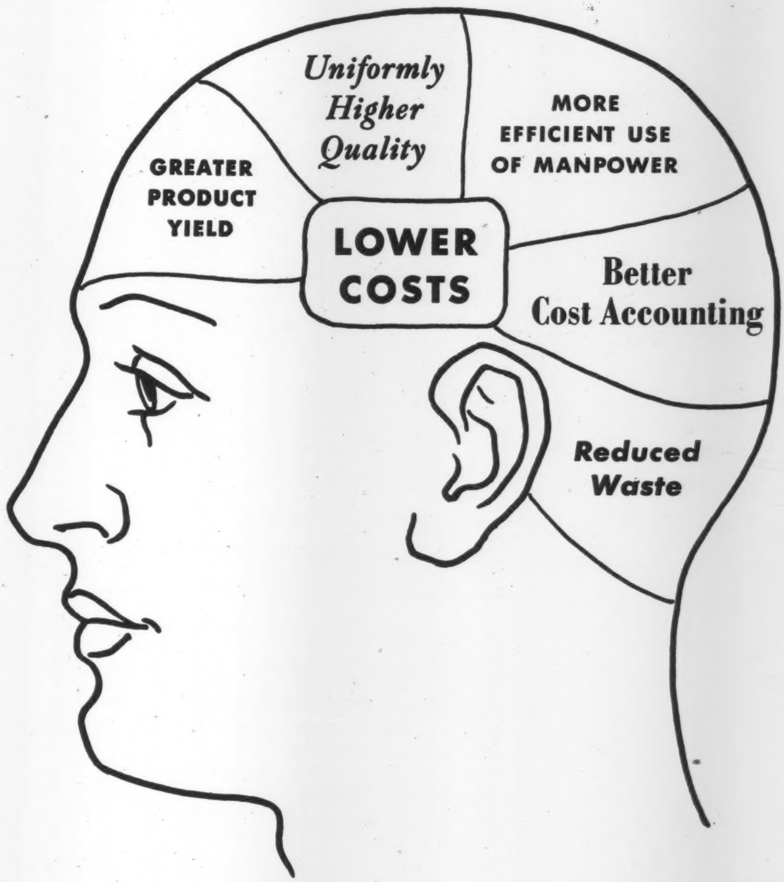
EVENING

"Instrumentation for the Power Plant of the Future"—Mike Boho, Hagan Corporation.

Top. Luncheon for the Speakers, Discussers, and Committee Members at the Meeting. President McMahon, Secretary Rimbach and Treasurer Feeley were also present.

Bottom. Part of the audience at the opening session of the Philadelphia Section Boiler Instrumentation Symposium.

An Instrument Man has a head for profits!



There's at least one man in every industrial plant who knows how to cut processing costs when raw materials and wages are going up. He knows there is scarcely an industrial process that can't be run better and more economically with up-to-date indicating, recording, and controlling instruments.

Waste and rejects are automatically reduced when instruments duplicate ideal results time after time. New instrumentation developed in recent months has a degree of accuracy in measurement and control never before thought possible. Miniature recorders and indicators that not only permit smaller control panels and control rooms, but are ideal for the new flow-chart type of graphic panels. Integrating flowmeters isolate departmental processing and heating costs.

With manpower shortages ahead, it's important to remember that instruments relieve the operator of responsibility for the quality of the finished product. In many instances, one skilled operator can now give a whole department the benefit of his experience.

▪ ▪ ▪

Executives in process industries should ask their Instrument Engineer how instruments can help turn a high cost processing operation into a more profitable one.

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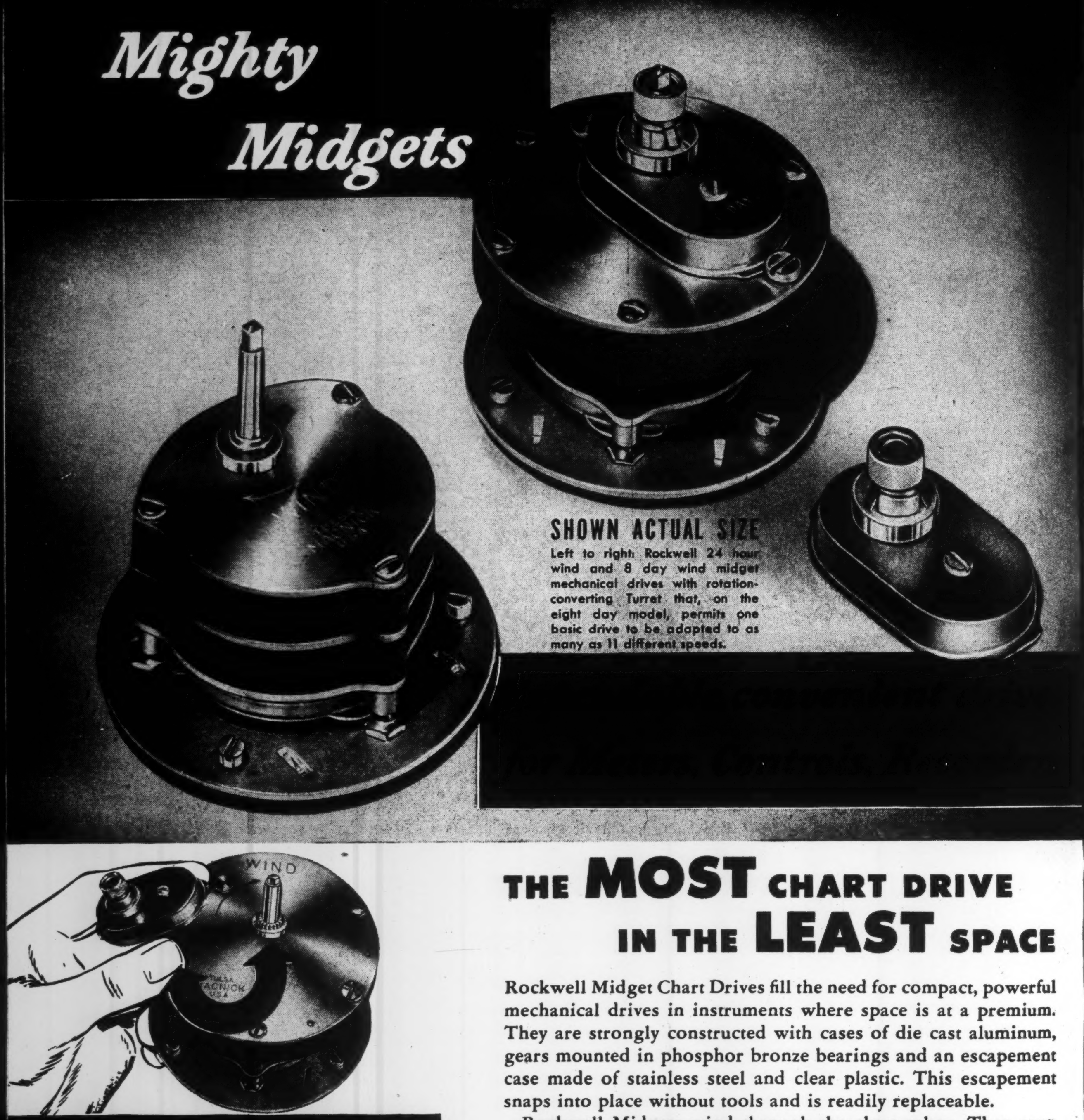
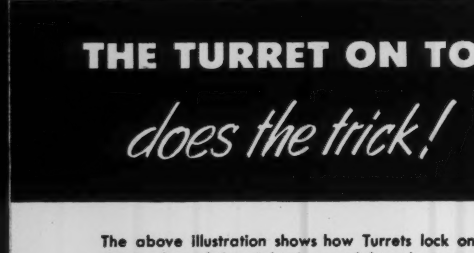
Mighty Midgets



SHOWN ACTUAL SIZE

Left to right: Rockwell 24 hour wind and 8 day wind midget mechanical drives with rotation-converting Turret that, on the eight day model, permits one basic drive to be adapted to as many as 11 different speeds.



THE TURRET ON TOP

does the trick!

The above illustration shows how Turrets lock onto the chart arbor of the eight day model to change rotation speeds. The eight day drive is basically 24-hour rotation. Turrets are available for chart rotation times of 2, 3 4, 6, 8, 12 and 48 hours; 3, 7 and 8 days.

THE **MOST** CHART DRIVE IN THE **LEAST** SPACE

Rockwell Midget Chart Drives fill the need for compact, powerful mechanical drives in instruments where space is at a premium. They are strongly constructed with cases of die cast aluminum, gears mounted in phosphor bronze bearings and an escapement case made of stainless steel and clear plastic. This escapement snaps into place without tools and is readily replaceable.

Rockwell Midgets wind through the chart arbor. They snap into a separate mounting ring only 3¼" in diameter which may be positioned on bosses or adaptors to fit any instrument case.

This combination of small size, versatility of application and precision construction makes Rockwell Midgets the most economical drives to use. It will pay you to specify them in instruments made by any manufacturer.

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ROCKWELL CHART DRIVES

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RING BALANCE METERS

by
J. R. SHAFER
Hagan Corp.

Ring balance meters have fast response, deflection characteristics which are particularly suitable for linear flow scales, wide operating ranges of differential and static pressures, and easy calibration technique. This article describes the principles, features, and typical applications of "Hagan Ring Balance Meters."

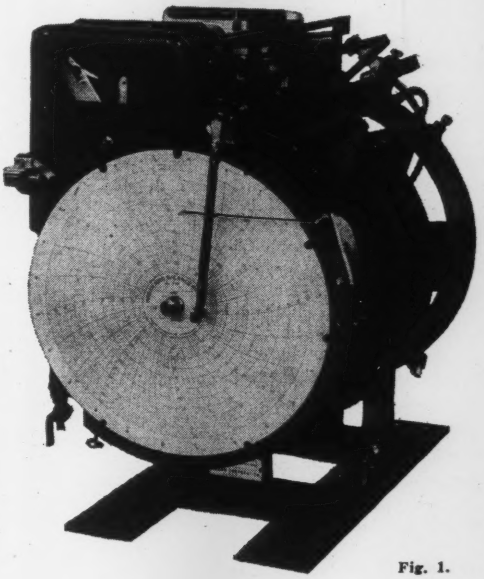

Fig. 1.

RING balance meters can function accurately over extremely wide ranges of both differential and static pressures and under severe operating conditions. As shown in Fig. 2, the basic element of the ring balance meter is a hollow ring which is divided into two compartments by a baffle inside the top of the ring and by sealing fluid at the bottom. This ring structure is mounted on a knife-edge bearing, located at the center of the ring, which permits rotation of the ring about its axis. Flexible connections from the pressure pipes are made to the two compartments of the ring, thus transmitting the pressure differential produced by the primary measuring device upon the area of the baffle. A torque proportional to the pressure differential times the area of baffle is established.

When there is no flow past the orifice, the pressure differential across the ring baffle is zero, and the ring is undeflected. However, as shown at the right in Fig. 2, the ring is deflected when a pressure differential is transmitted to the area of the baffle in the ring. The unit is suited for recording or indicating differentials only.

Rotation of the ring is opposed by a resistance system consisting of a push rod operating from a knife edge

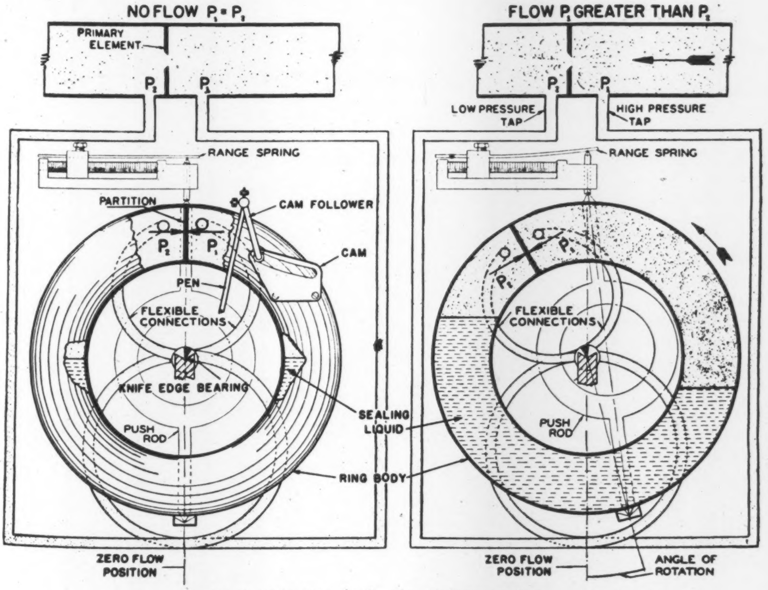
NO FLOW $P_1 = P_1$
PRIMARY ELEMENT
P_2
P_1
RANGE SPRING
PARTITION
CAM FOLLOWER
CAM
PEN
FLEXIBLE CONNECTIONS
KNIFE EDGE BEARING
PUSH ROD
SEALING LIQUID
RING BODY
ZERO FLOW POSITION
FLOW P_1 GREATER THAN P_2
LOW PRESSURE TAP
HIGH PRESSURE TAP
RANGE SPRING
FLEXIBLE CONNECTIONS
PUSH ROD
ZERO FLOW POSITION
ANGLE OF ROTATION

Fig. 2. Principle of the ring balance meter.

Presented at the regular monthly meeting of the SCMA, October 18, 1951.

January Meeting: Thursday, the 17th, 1952, Rio Hondo Country Club, Downey, Calif. Dinner at 6:30, meeting at 8:00 P.M.

Feature: "The Dynamics of Pulsative Flow through Sharp-edged Restrictions" by Ira C. Bechtold, Fluor Corp.

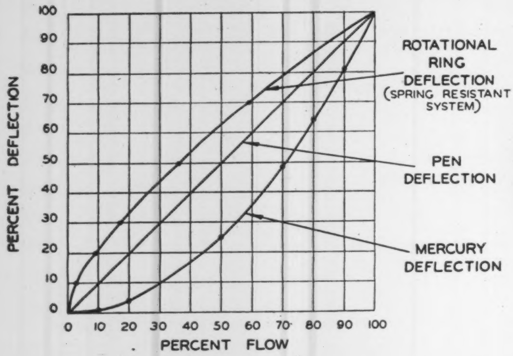

Fig. 3. Deflection characteristics of ring-deflection spring-resistant system, mercury-displacement system, and desired linear response.

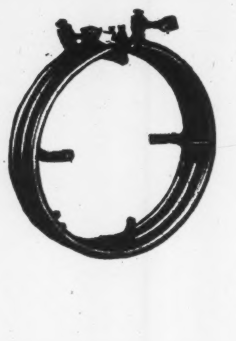

Fig. 4. The "R91" ring, consisting of three rings in series.

attached to the lower part of the ring. The push rod pushes against a leaf spring. The position assumed by the ring results from a balance between ring torque and the resisting force of the spring. The action of the resistance system on rotation of the ring is the resultant of both horizontal and vertical components of the movement of the knife edge suporting the lower end of the push-rod assembly.

DEFLECTION CHARACTERISTICS

The effect of the spring resistance system is illustrated in Fig. 3. The curves show the movement both of the conventional mercury-displacement-type meter and of the ring structure of the ring balance meter at all rates of flow. The diagonal straight line represents the final pen movement which must be secured if a uniformly graduated chart is desired.

As shown in Fig. 3, a magnified flow reading is produced by the ring balance meter at low rates of flow. Fig. 3 shows also that the conversion of the ring motion into a pen movement which is linear with flow requires a cam, or other correcting mechanism, with a gradual slope throughout the full chart range.

In contrast with this, the conventional float-type meter produces a float movement proportional to the measured differential. This varies as the square of the rate of flow. Therefore, the mechanical conversion of this movement into a linear flow chart requires a cam whose slope is relatively steep at low rates of flow. In other words, the motion of the measuring element must be magnified at low rates. For example, a conventional meter produces 20-percent float movement at 45-percent float rate, whereas the ring balance meter shows 20-percent ring motion at 9-percent flow rate. This illustrates how the ring balance meter magnifies readings of low flow rate.

Similar comparisons indicate the inherently high mechanical accuracy of the ring balance meter at low rates of flow. This in turn permits accurate metering with wide ranges of flow variation; in many applications it is unnecessary to use "high-range" and "low-range" meters on the same line.

It can be shown mathematically that the hydrostatic forces resulting from the deflection of the sealing fluid in a circular-ring are normal to the containing circle, and pass radially through the exact center of rotation. This produces zero torque effect in the ring and eliminates all factors except the pressure differential acting on the area of the ring baffle and the spring resistance system.

The quantity of sealing fluid is not critical so long as the depth of seal is sufficient for the pressure differential imposed on the ring. Neither the position of the sealing fluid in the ring nor the inertia of a moving body of sealing fluid can have any effect on ring movement.

Response of the ring can be as fast as is necessary to follow changes in the pressure differential, without affecting the accuracy of the chart reading, which is a record only of the pressure differential acting on the ring baffle. Thus the ring balance meter is designed without any dampers or averaging devices, and without any provisions for attaching such devices. On the contrary, every means is used to make ring response as fast as possible.

The adjustment of the length of the range spring determines the meter calibration. Lengthening the effective spring length reduces the pressure differential required for full-scale deflection; shortening the effective length of the spring increases the pressure differential corresponding to full scale. As an example, the range of adjustment on a single ring with mercury seal can be changed from 20-in. to 140-in. water column simply by changing the effective length of the spring.

Two or three rings may be connected in a single assembly in series, as shown in Fig. 4. The maximum pressure differential of the standard meter may thereby be increased to 280-in. water column with two rings in series or to 420-in. water column with three rings in series. A standard meter case is used for each of these assemblies. Other ring assemblies are designed for full-scale deflection for as little as ½-in. water column.

INTEGRATOR

The integrator of the ring balance meter is designed for high accuracy between 2 and 100 percent of full-scale range. The integrator consists essentially of a time-cycle lever, including a toggle and pawl assembly, which is driven from a synchronous motor by a chain drive. The integrator can be checked with the meter in service or out of service, and can be adjusted by means of a single adjustment.

CALIBRATION

Calibration of the ring balance meter, either as routine or when moving to a new location, is simple and accurate. Calibrating check weights are furnished with each meter. The check test can be made with the ring under full static pressure, and with the equalizing valve open. Each weight, when suspended from the ring assembly, corresponds to a definite value of pressure differential in inches of water column.

The calibration method is particularly desirable when working with compressible fluids at elevated pressure. It also permits moving a meter from one orifice to another, and requires only the adjustment of the range spring for the full-scale pressure differential at the new location.

FEATURES AND APPLICATIONS

Another outstanding feature of the ring balance meter is the absence of all stuffing boxes, pressure-type bearings, and other devices which might be sources of friction or leakage. The

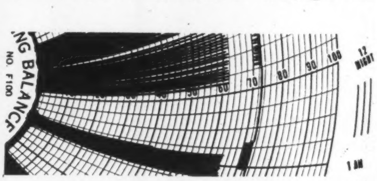

Fig. 5. Portion of a 24-hr. chart of oxygen flow to scarfing machine, illustrating rapid variation in flow.

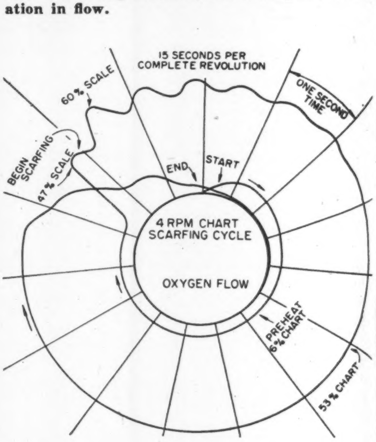

Fig. 6. Expanded record of one cycle of scarfing operation of Fig. 5, made by increasing chart speed to 4 rpm.

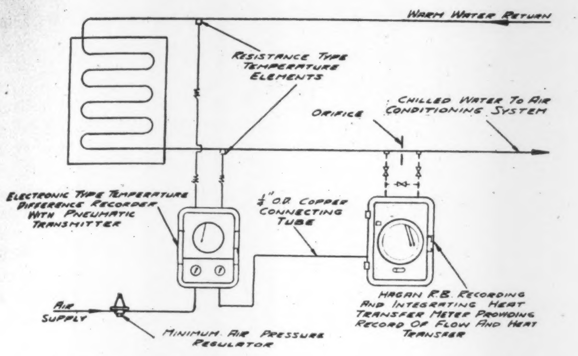
Warm Water Return
Resistance Type Temperature Elements
Chilled Water To Air Conditioning System
Orifice
Electronic Type Temperature Difference Recorder With Pneumatic Transmitter
¼" O.D. Copper Connecting Tube
Air Supply
Minimum Air Pressure Regulator
Hagan R.B. Recording And Integrating Heat Transfer Meter Providing Record Of Flow And Heat Transfer

Fig. 7. Heat-transfer system which multiplies rate of fluid flow by temperature difference.

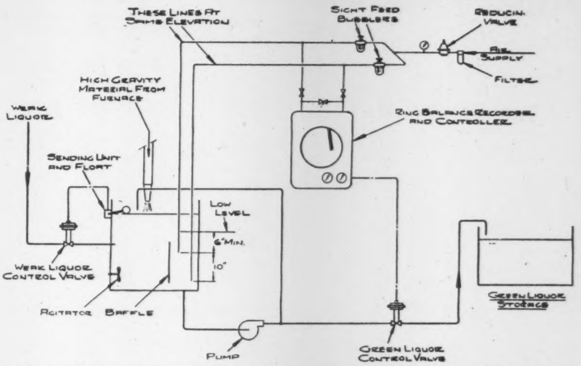
These Lines At Same Elevation
Sight Feed Bubblers
Reducing Valve
Air Supply
Filter
High Gravity Material From Furnace
Weak Liquor
Ring Balance Recorder And Controller
Sending Unit And Float
Low Level
6" Min.
10"
Weak Liquor Control Valve
Agitator
Baffle
Green Liquor Storage
Pump
Green Liquor Control Valve

Fig. 8. System for controlling the specific gravity of green liquor in a paper mill.

design of the pressure parts depends only on the size and strength of the materials entering into the construction. The measurement of a maximum differential of, for example, 25-in. water column is made with equal ease and accuracy at a static pressure of 15 psig. or at 15,000 psig. The basic design remains the same; only the strength of the pressure parts is changed.

The standard meter case has room for two independent rings, measuring two separate quantities and having two separate pens registering on a single chart. Either or both measuring elements can be high-pressure and high-differential units, or low-pressure and low-differential units.

Computing. We are all familiar with the pumps at a gasoline station, which not only measure the flow of gas to the automobile but also multiply the number of gallons by the price. They produce a totalized record of both the total gallons sold and the value of the transaction. Similar computations have a definite value in industrial processes. One of the principal benefits is the ability to go directly to the variable of greatest interest and eliminate laborious calculation. Computing instruments are already in successful use in many plants, in services such as recording a gas flow which is corrected automatically for density changes, recording the rate of heat and energy flow, or recording one component of a mixed flow.

Two developments in the design of ring balance meters have made such computing instrumentation practical in the industrial meter field. The first of these developments is the dual meter (Fig. 1), which consists of two separate meters mounted in the same housing, arranged to record on a single chart, and designed so that the displacement of the two recording mechanisms can be combined. The second development is a series of coupling linkages which make the desired computations.

The coupling linkages are of two basic types—additive and multiplying. The additive coupling is designed to produce an output displacement which is either the sum or the difference of two input displacements. The multiplying coupling is designed to produce an output displacement which is either the product or the ratio of two input displacements. Several examples show how these relatively simple elements can be combined to effect solutions to unusual metering problems.

Scarfing Machine. In one application, a ring balance meter produces an accurate record under unusually severe flow conditions. Fig. 5 is a portion of a 24-hr. chart record of oxygen supplied to a scarfing machine. The record is taken from a meter equipped with both temperature and pressure compensation. Therefore, the oxygen flow represents a corrected flow referred to standard conditions. Each cycle lasts for approximately two minutes; the cycles sometimes are repeated 28 times per hour.

In order to examine the meter response in detail, a special clock was installed which rotated the chart through 360 degrees in 15 seconds, thus magnifying each cycle 5,760 times. Fig. 6 shows the expanded cycle.

The figure shows graphically the severity of the service and the rapid response of the meter. The oxygen begins to flow at the point marked "start," and increases to a rate of about 6 percent of the chart range during a period of approximately 12 seconds. At this time, the scarfing nozzles open and the meter pen moves to approximately 45 percent of scale in one-quarter second. The flow finally settles out at 53 percent of chart range, and the scarfing process lasts 14 seconds, at which time the flow drops to zero. This may be analyzed as the measurement of 6 percent of chart range for a period of 12 seconds and 53 percent of chart range for 18 seconds, or an average over a period of one hour of 8 percent of full scale.

Heat-transfer system. Fig. 7 is the diagram of a metering system for the measurement of heat transfer. The equipment cools water for an air-conditioning system in a building and requires a record and an integration of the amount of refrigeration for sales-billing purposes. In this installation, water for the cooling system is received from a separate plant. Both the degree of cooling and the amount of water used are variables which depend on weather conditions.

The measuring is accomplished by multiplying the temperature difference between incoming and outgoing water by the flow of water. A resistance-type temperature-differential recorder, fitted with a pneumatic transmitter, generates a signal which is connected to a bellows in the water-meter case. A multiplying coupling multiplies this by the rate of flow; the meter also records the temperature difference, rate of water flow, and rate of refrigeration. The continuous integration of the refrigeration is the basis for billing.

Specific-gravity control. Fig. 8 shows the use of the ring balance meter in maintaining the gravity of green liquor in a paper mill. In this system, a float mechanism is used to control the level of a mixture of high-gravity material and liquor by operating a control valve in the liquor supply line. A ring balance meter measures the difference in head between two points in the mixing tank, this head being representative of the specific gravity of the mixture. The meter is fitted with a pneumatic transmitter and permits the mixture to be removed from the mixing tank to a storage tank through a control valve as the specific-gravity condition indicates the need for a higher percentage of new liquor in the mixing tank. This application has been used with slight modifications in the solution of a number of problems involving specific gravity of liquids.

The examples given do not represent the limits of application of the ring balance meter because it is possible in one meter housing to effect a computation, to convert the result into a pneumatic control signal, and to introduce that signal into a second meter housing for combination with measurements of other variables. Such modifications are almost infinite in variety. Ring balance meters also can be equipped with pneumatic or electric transmitting units to provide signals for remote indicating, recording, or controlling systems.

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1521.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

Temperature

T-974 **Temperature Recorder.** 12-page article (reprint) "Deflection-type Temperature Recorder" is profusely illustrated and covers principles, design, operation, and advantages of maker's deflection-type recorder.—Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

T-975 **Indicating Pyrometers.** 8-page illustrated Bulletin 1051 describes new line of indicating pyrometers and resistance thermometers containing enclosed plug-in galvanometer unit. Includes wiring diagrams, scale ranges, external-circuit data.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Wayne & Windrim Aves., Philadelphia 44, Penna.

T-976 **Temperature Control.** 2-page Bulletin CL-1 illustrates and describes "Capaciline" supplementary control device which adds anticipatory response to existing on-off pyrometer control circuits.—Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

T-977 **Thermometers.** 4-page Specification Sheet 600 describes maker's indicating and recording thermometers. Construction and engineering details are included.—Industrial Div., Station 40, Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Penna.

T-978 **Resistance Thermometer Elements.** 4-page Bulletin T-1B describes and illustrates maker's "Stikon" resistance-thermometer elements. Covers characteristics, specifications, and prices.—Ruge-de Forest, Inc., 84 Massachusetts Ave., Cambridge 39, Mass.

T-979 **Thermocouple Wells.** 28-page Catalog 200-1 presents information on proper selection of wells and well material; includes photographs and drawings of maker's large line of wells.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Wayne & Windrim Aves., Philadelphia 44, Penna.

T-980 **Pyrometer Supplies.** 44-page illustrated Catalog 100-4 (Buyers' Guide) gives technical data and applications of thermocouple pyrometric supplies. Includes maker's complete line, prices, selection data and ordering procedure.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Philadelphia 44, Penna.

T-981 **Industrial Freezers.** 4-page bulletin describes and illustrates freezers for testing, experimenting, and seasoning in temperature ranges from −165 to 200 F.—Industrial Div., Webber Appliance Co., Inc., 2470 Madison Ave., Indianapolis 3, Ind.

Flow

T-982 **Flow and Level.** 16-page Bulletin 420-1 describes and illustrates d/p cell for flow and liquid-level measurement. Covers operation, specifications, installation. Describes "Model 40" recorder-controller, pneumatic receivers, electric-type 3E d/p cell, and "Dynalog" electronic recorders.—The Foxboro Co., Foxboro, Mass.

T-983 **Controlled-volume Pumps.** 24-page illustrated Bulletin No. 251 describes motor-driven controlled-volume pumps for liquids, solids in suspension, abrasive slurries, liquified gases, and other materials. Includes operation details and capacity pressure selection tables.—Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Penna.

T-984 **Rotameters.** 8-page Bulletin 110 illustrates and describes maker's large line of full-view and armored rotameters, purge meters, and controlling instruments for flow-rate measurement. Covers features, operation and specifications.—Brooks Rotameter Co., Lansdale, Penna.

T-985 **Flowmeter Calibration Service.** 8-page Catalog 100 presents details of calibration service offered to industry. Unique facilities for determining fluid characteristics are illustrated and discussed.—Fischer & Porter Co., 5060 County Line Rd., Hatboro, Penna.

Radioactivity

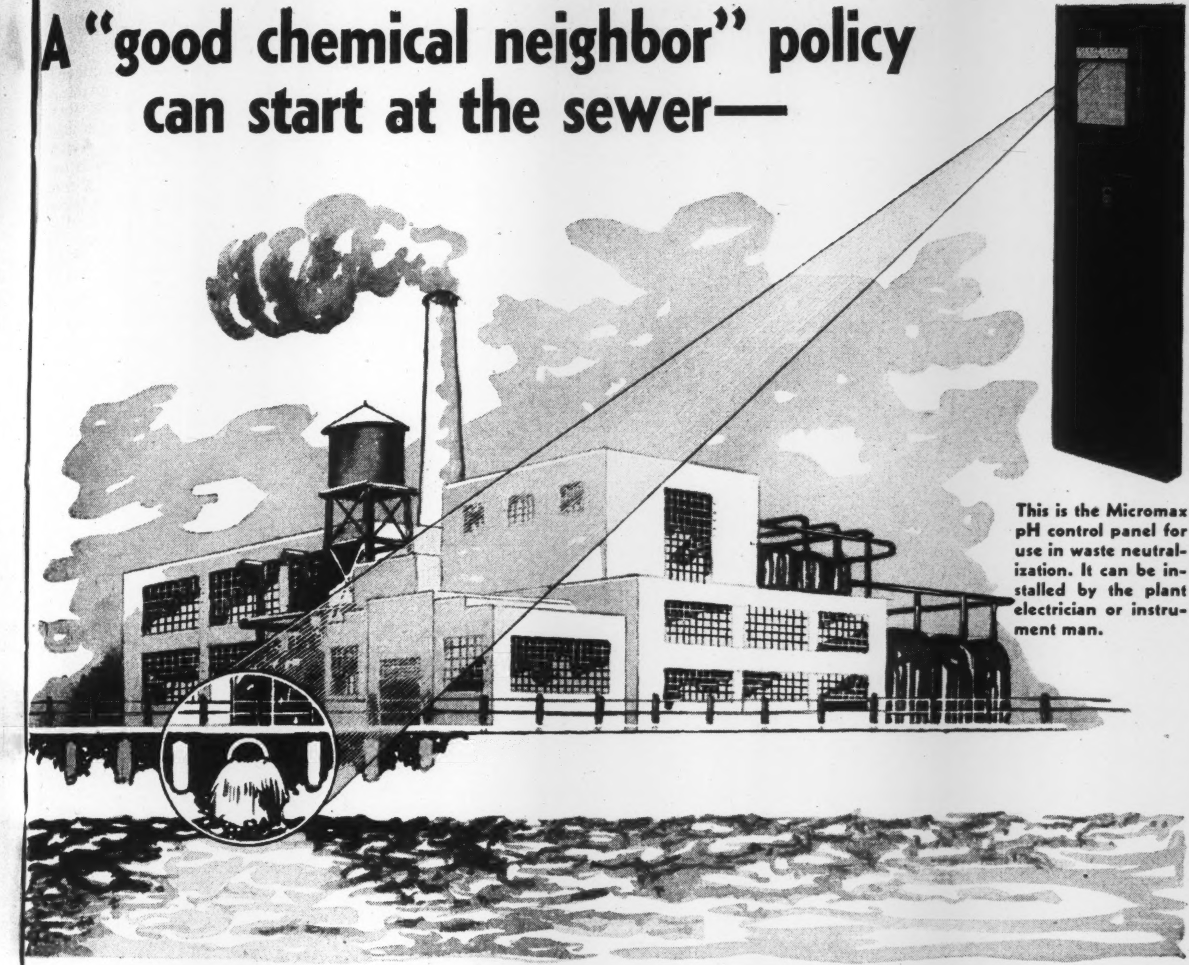
T-986 **Radioactivity Monitors.** 4-page Bulletin S8-851 describes and illustrates low- and high-level monitoring instruments, background monitors, food and water analysis equipment.—Nuclear Instrument and Chemical Corp., 223 W. Erie St., Chicago 10, Ill.

T-987 **Radioactivity Equipment.** 108-page Catalog C illustrates and describes maker's extensive line of radioactivity equipment, tagged chemicals and consulting services.—Tracerlab, Inc., 130 High St., Boston 10, Mass.

Process Controllers

T-988 **Process Controllers.** 16-page Catalog 8000 illustrates and describes maker's "Electr-O-Vane" vane-type electric-contact process-control units. Also described are the "ElectroniK" potentiometer and "Pyr-O-Vane" and "Protect-O-Vane" millivolt meters, which give sensitive on-off, two-po-

A "good chemical neighbor" policy can start at the sewer—



This is the Micromax pH control panel for use in waste neutralization. It can be installed by the plant electrician or instrument man.

THE **sewer outfall** marks the spot where a plant can prevent stream pollution, by discharging only wastes which have been properly treated. And, when proper treatment is linked to pH control, we can probably help . . . effectively. We can assist engineers o set up good "chemical relations" between a company and the rest of the community . . . make the plant a good chemical neighbor.

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Controllability analysis predicts actual results. Through long experience with pH control applications, we have developed a unique system of "controllability analysis". By scientifically weighing all pH control factors — type of waste, treating system, reagent—this analysis determines the net control effect possible for a given waste-treating system.

If you're planning pH control, you can't afford to miss this special service. Our catalog "Effective Neutralization of Industrial Wastes" explains controllability analysis in full detail. For your convenience, it also contains a simple questionnaire . . . so we can help you begin solving your plant's pH problems now. You can answer the questions in just a few minutes.

Ask for Bulletin ND44-96-708. Address Leeds & Northrup Company, 4955 Stenton Ave., Phila. 44, Pa.

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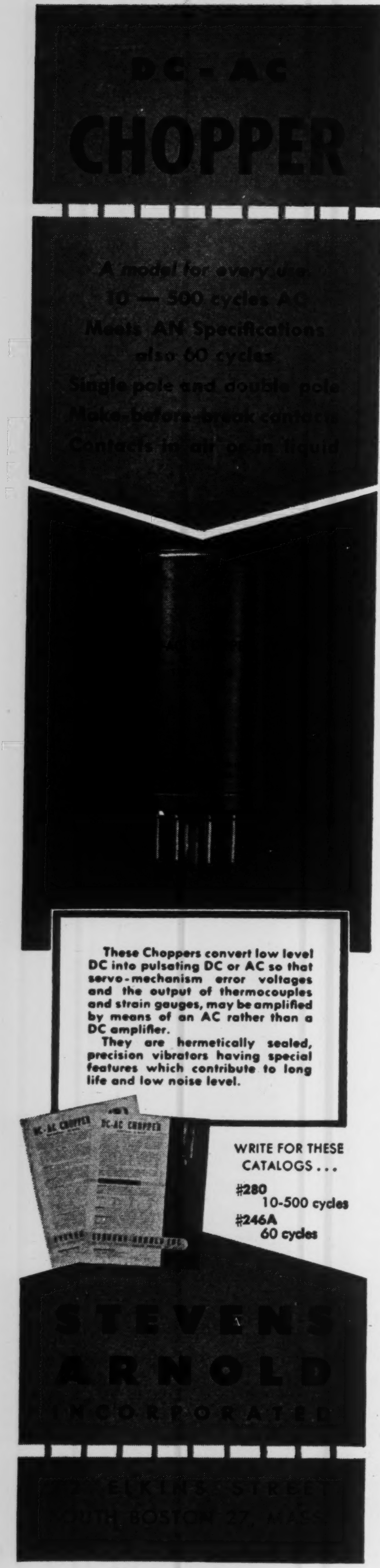
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NEW LITERATURE

Process Controllers Continued

sition, or three-position control. Includes principles and specifications.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Wayne & Windrim Aves., Philadelphia 44, Penna.

T-989 **Process Controllers.** 4-page Specification Sheet 768 illustrates and describes "Tel-O-Set" controllers for process control including temperature, pressure, flow, and liquid level. Includes characteristics, specifications, and operation data.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Wayne & Windrim Aves., Philadelphia 44, Penna.

T-990 **Self-operated Controllers.** 4-page illustrated Bulletin 1320 describes self-operated temperature and pressure controllers. Covers specifications, applications, control ranges.—Dept. 67, Tagliabue Instruments Div., Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

T-991 **Controllers.** 4-page illustrated Bulletin G-1 describes makers "Sim-Ply-Trol" contact-type, meter-relay controllers and accessories. Includes specifications, ranges, and prices.—Assembly Products, Inc., Main & Bell Sts., Chagrin Falls 1, Ohio.

T-992 **Process Control.** 8-page Vol. 11 No. 3 issue of "Modern Precision" features articles on pH indicators, temperature control of aluminum process, waste-treatment control, generator load control, power-level recorder, and others.—Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia 44, Penna.

T-993 **Servomechanism Technique in Process Control.** 20-page reprint of 1951 ISA paper "Practical Applications of Servomechanisms Techniques to a Process Control Problem," reviews progress in analysis of automatic control problems and illustrates new technique for solutions to typical flow-control problem.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Wayne & Windrim Aves., Philadelphia 44, Penna.

T-994 **Time and Sequence Control.** 8-page bulletin illustrates and describes drum-type controllers for process time and sequence control. Includes applications, specifications.—Seeley Instrument Co., Inc., 377 Fourth St., Niagara Falls, N. Y.

Steam, Water Level, etc.

T-995 **Boiler Level Controls.** 8-page illustrated "Bulletin S-18B" describes boiler water feeders, low-water cutoffs and pressure-relief valves. Includes capacities and service recommendations.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

T-996 **Water Level.** 20-page Bulletin WG-1811 (1951) illustrates and describes maker's large line of water columns and level gages. Includes operation, construction, dimensions, and typical installations.—Yarnall-Waring Co., Mermaid Lane, Philadelphia 18.

Continued on page 1514

THE following new advertising section will begin in the January 1952 issue of *Instruments.*

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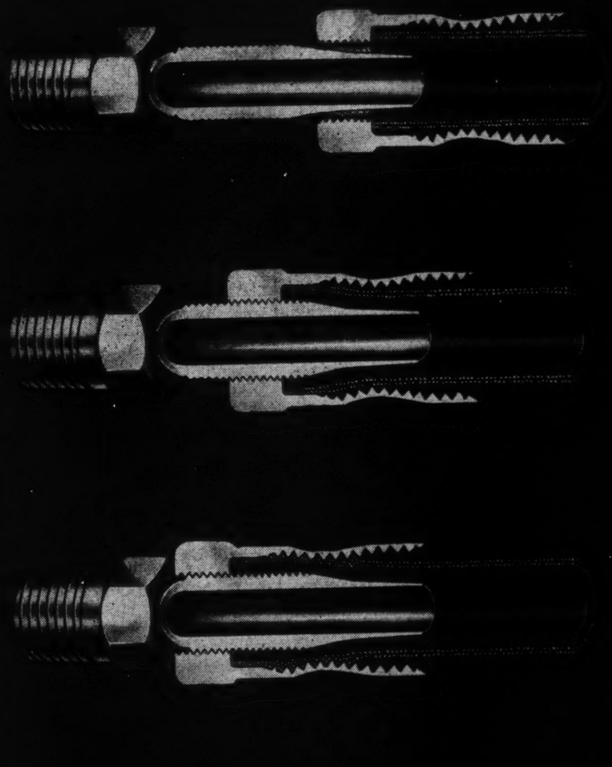

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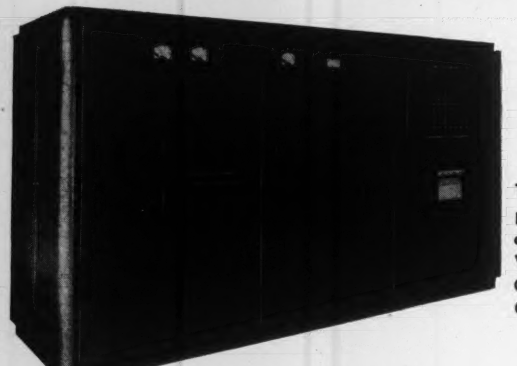

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Valves and Tubing

T-997 **Valves.** 20-page General Catalog 1500B illustrates and describes "Domotor," solenoid-operated automatic-manual, and handwheel valves. Covers advantages, design features, plugs, seats, packing, specifications, and capacity and flow data.—The Annin Co., 3500 Union Pacific Ave., Los Angeles 23, Calif.

T-998 **Three-way Diaphragm Valves.** 8-page bulletin illustrates and describes maker's "Series 108-805-5108" high-pressure three-way two-position hydraulic valves. Covers specifications and applications. — Seely Instrument Co., Inc., 377 Fourth St., Niagara Falls, N. Y.

T-999 **Metallic Bellows and Hose.** 16-page Catalog 123 illustrates and describes maker's large line of metallic bellows and flexible metal hose and tubing. Includes specifications, applications, and data on flanges, couplings, and fittings.—Chicago Metal Hose Corp., Maywood, Ill.

T-1000 **Tube Fittings.** 12-page Catalog B-151 describes and illustrates complete line of leakproof "Swagelok" tube fittings in brass, aluminum, steel, stainless steel, and Monel. Includes features and applications.–Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio.

T-1001 **Liquid Filters.** 8-page illustrated Folder 105 describes new synclinal filters for sump or line on hydraulic and low-pressure liquid recirculating system. Includes specifications, applications, and design features.—Marvel Engineering Co., 625 W. Jackson Blvd., Chicago 6, Ill.

T-1002 **Fluid Line Markers.** 2-page Bulletin 153 illustrates and describes fluid-line identification markers. Covers features, application, prices.—Dept. 248, W. H. Brady Co., 1602 E. Spring St., Chippewa Falls, Wis.

Optical

T-1003 **Phase-contrast Microscope.** 4-page bulletin illustrates and describes "Galileo (Italian-made) Type VNP" phase-contrast microscope. Covers features, specifications, operation. Distributed by Metallurgical Instrument Co., 2454 W. 38 St., Chicago 32, Ill.

T-1004 **"Photoelastic Stress Analysis."** 20-page booklet covers principle of photoelasticity, apparatus, and photographic data. Gives list of manufacturers of equipment for photoelastic stress analysis; also bibliography on subject. Price 35 cents.—Eastman Kodak Co., Rochester 4, N. Y.

T-1005 **Step-gage.** Bulletin GEC-837 illustrates and describes features and applications for new step gage which measures thickness of thin films by color comparison. — General Electric Co., Schenectady 5, N. Y.

T-1006 **Glossmeters.** 2-page Bulletin 101 describes new optical instruments for gloss measurements. Covers features, operation, prices.—Henry A. Gardner Laboratory, Inc., Bethesda, Md.

T-1007 **Metallurgical Instruments.** Bulletin illustrates "Galileo" Italian-made hardness testers, comparators, polishers, metallographs, microscopes, and macro-photographic equipment available from Opplem Co., Inc., 352 Fourth Ave., New York 10, N. Y.

Chemical Laboratory

T-1008 **Laboratory Apparatus.** 52-page Vol. 4, Fall 1951 edition of "Scientific Apparatus and Methods" features articles on mercury cathode vessels, Van Slyke apparatus, polarographs, pH meters, furnaces, refractometers, and other laboratory apparatus.—E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.

T-1009 **Laboratory Apparatus.** 12-page Vol. 8, No. 5 issue of "Aminco Laboratory News" describes temperature test chambers, spectrophotometers, etc. Includes news items on laboratory technique, tooling, and production control.—American Instrument Co., Inc., 8030 Georgia Ave., Silver Spring, Md.

T-1010 **Laboratory Apparatus,** 28-page No. 73 issue of "Cenco News Chats" includes features on textile industry, microscopes, photomicrographs, heat-conductivity apparatus, electrochemical analysis, metering pumps, and other laboratory items.—Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.

T-1011 **Laboratory Apparatus.** 20-page No. 51-10-44 issue of "Burrell Announcer" describes combustion train, automatic titrators, spectroscopic methods of analysis, radiation monitors, and accessories. Also feature article "Chemical Spectroscopy."—Burrell Corp., 2223 Fifth Ave., Pittsburg 19, Penna.

T-1012 **Laboratory Apparatus.** 20-page No. 51-10-4 issue of "Griner Announcer" illustrates and describes apparatus for carbon determination, qualitative analysis, automatic titrators, radiation monitor, and laboratory microscopes. Includes feature article "Chemical Spectroscopy."—A. J. Griner Co., 1827 McGee St., Kansas City 8, Mo.

T-1013 **Fluorescence Detector-comparator.** 4-page bulletin illustrates and describes "Fluoretor" portable ultraviolet-generator fluorescence-tester which can be used in daylight. Describes sample holders and viewing accessory.—Menlo Research Laboratory, P.O. Box 522, Menlo Park, Calif.

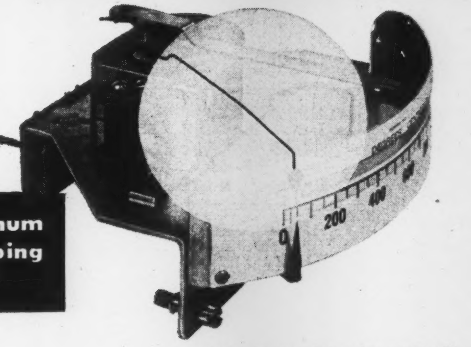
T-1014 **Filter Papers.** 40-page Catalog 70 contains reference material on chemical analyses and biological procedures. Includes description of large line of filter papers and accessories.—Schleicher & Schuell Co., Keene, N. H.

T-1015 **Atom Model.** 6-page circular illustrates and describes new "Underwood" dynamic atom model for use in instruction on atomic structure, chemical valence, formation of compounds, etc.—W. M. Welch Mfg. Co., 1515 Sedgwick St., Chicago 10, Ill.

Chemical Process Analysis

T-1016 **pH Indicator.** 8-page Folder EM9-96(1) illustrates and describes new stabilized line-operated pH indicator which reads to 0.02 pH with no range changing. Covers applications, advantages, specifications, and accessories.—Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia 44, Penna.

T-1017 **pH and Conductivity Recorders.** 40-page Catalog 15-16 illustrates and describes maker's pH and conductivity recorders and controllers. Covers



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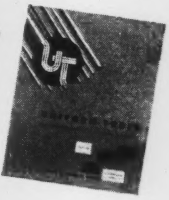

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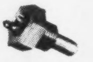
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fundamentals, measuring and control systems, applications, instrument specifications, and system components.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Wayne & Windrim Aves., Philadelphia 44, Penna.

T-1018 **Spectrometer.** 2-page illustrated bulletin describes recording X-ray spectrometer in unit package. Covers features, operation.—Ohio X-Ray, Inc., 994 Broadway, P.O. Box 169, Bedford, Ohio.

T-1019 **Boron Analysis.** 4-page Vol. 4 No. 4 issue of "Spectographic News Letter" features article on direct-reading analysis of boron in low alloy steels. Contains feature on cleaning spectrographic instruments, relays, and Quantometer slits.—Applied Research Labs., Glendale 4, Calif.

Weight

T-1020 **Weighing and Proportioning.** 60-page illustrated Catalog 841 describes large line of equipment for industrial weighing, weight feeding, vibration feeding, batching, conveying, and proportioning.—The Jeffrey Mfg. Co., Columbus 16, Ohio.

T-1021 **Hydraulic Crane Scales.** 6-page illustrated bulletin describes "Hydroscale" which weighs automatically (to 50 tons) as load is lifted. Covers features, applications, dimensions.—Hydroway Scales, Inc., 20624 W. 8 Mile Rd., Detroit 19, Mich.

T-1022 **Weight Transmitter.** 8-page Catalog 100-A describes "Air-Scale" pneumatic weight transmitter. Covers advantages, operation, applications, selection, and specifications.—Fluid Controls Co., Inc., 5150 Ridge Ave., Philadelphia 28, Penna.

Electrical and Electronic Instruments

T-1023 **Electronic Instruments.** 4-page booklet describes and illustrates maker's line of signal, square-wave, and pulse generators, noise and field-strength meter, megacycle meter, I.F. converter, VTVM's, and other instruments. Includes characteristics and dimensions.—Measurements Corp., Boonton, N. J.

T-1024 **Micro-ohmmeters.** 2-page Engineering Bulletin L12A describes line of low-resistance test sets. Includes applications, specifications, ranges.—Shallcross Mfg. Co., Collingdale, Penna.

T-1025 **Oscillographs.** 12-page Vol. 1 No. 4 issue of "Hathaway Engineering News" features article on measurement of strain and description of various oscillograph applications.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.

T-1026 **Oscillograph.** 8-page illustrated bulletin describes "Dynograph" sensitive drift-free chopper-type d-c. recorder. Covers operation, application, features.—Offner Electronics Inc., 5320 N. Kedzie Ave., Chicago 25, Ill.

T-1027 **Potentiometer Recorder.** 16-page Bulletin B15-13 discusses the characteristics of the measuring circuits used in the "Brown ElectroniK" potentiometer. It is the second of a series of bulletins describing features and applications.—Brown Instruments Div., Station 40, Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Penna.

T-1028 **Continuous Balance System.** 30-page Bulletin B15-12 illustrates and describes circuit and characteristics of amplifier and motor combination of the "Brown Continuous Balance" system. It is the first in a series discussing features and applications of maker's potentiometer-recorder system.—Brown Instruments Div., Station 40, Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44. Penna.

T-1029 **Graphic Instruments.** 16-page booklet "Solving Industrial Crimes —Case No. 41" describes use of maker's graphic wattmeter in realignment of crane runway. Includes descriptions of speed recorders and indicators, recording ohmmeters. time, and pressure recorders.—The Esterline-Angus Co., Inc., Indianapolis, Ind.

T-1030 **Volt-ammeter.** 16-page Manual No. 504 presents 11 case histories on different uses of "Amprobe" snap-around volt-ammeter. Includes specifications.—Pyramid Instrument Corp., 49 Howard St., New York 13, N. Y.

T-1031 **Square-wave Generator.** 2-page bulletin illustrates and describes versatile square-wave generator with frequency range of 6 to 1,000,000 cps. —Electro-Mechanical Research, Inc., Ridgefield, Conn.

T-1032 **Broad-band Amplifier.** 2-page bulletin illustrates and describes features of broad-band high-gain direct-coupled amplifier. — Electro-Mechanical Research, Inc., Ridgefield, Conn.

T-1033 **Dust Recorder.** 4-page Instrumentation Data Sheet No. 10.14-6 "Unit Measuring Systems," illustrates and describes use of General Power Plant gas analyzer with "ElectroniK" recording potentiometer for continuous recording of dust content.—Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Station 40, Wayne and Windrim Aves., Philadelphia 44, Penna.

T-1034 **Data Analyzer.** 4-page booklet illustrates and describes automatic data analyzer for converting telemetry line-film records into calibrated time plots. Includes operation, application, and accuracy.—Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.

T-1035 **Data Recorder.** 4-page illustrated bulletin describes "Codograph" for automatic graphical plotting from digital IBM card data. Covers operation, accuracy, and applications.—Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.

T-1036 **Slotted-line Measurements.** 4-page Vol. 3, No. 1 issue of "hp Journal" features article "Good Practice in Slotted Line Measurements." Pictures typical setups and practical factors.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

T-1037 **Distortion-measuring Equipment.** 4-page Vol. 2, No. 12 issue of "hp Journal" features illustrated article on measurement of harmonic distortion. Includes descriptions of maker's "Model 330" distortion meter, "Model 320B" distortion analyzer, and "Model 300A"

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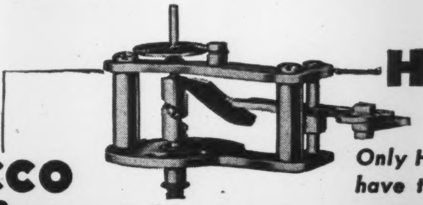

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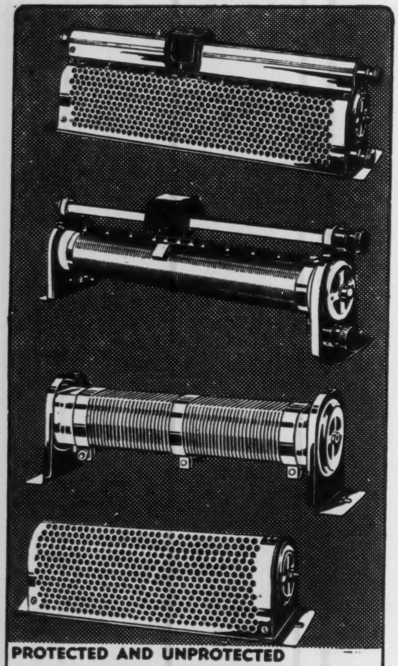
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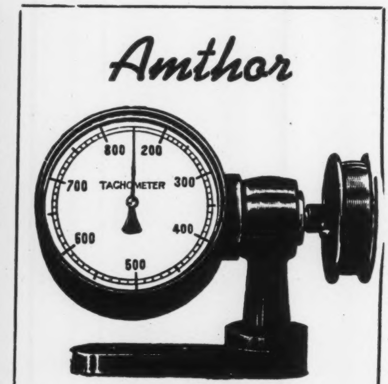
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harmonic wave analyzer.—The Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.

Electrical and Electronic Components

T-1038 **Electronic Components.** 1100-page hard-cover bound 1952 general catalog describes over 75000 items with 7000 illustrations of major standard-brand radio-electronics products. Includes technical specifications, dimensions and prices. Write on company letterhead to—Dept. CP, Milo Radio an Electronics Corp., 200 Greenwich St New York 7, N. Y.

T-1039 **Electronic Components.** 212-page 1952 Catalog 127 illustrates and describes thousands of electronic components and test instruments handled by distributor.—Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

T-1040 **Electronic Components.** 64-page Catalog No. 155 illustrates and describes maker's line of radio chemicals, electronic components, service aids and tools, alignment tools, and hardware.—General Cement Mfg. Co., 91 Taylor Ave., Rockford, Ill.

T-1041 **Electronic Components.** 32-page buyer's guide lists large line of electronic components and test instruments handled by distributor.—Concord Radio Corp., 901 W. Jackson Blvd., Chicago 7, Ill.

T-1042 **Deposited-carbon Resistors.** 4-page Bulletin PC1 illustrates and describes maker's line of deposited-carbon resistors with either glass sleeve or humidity-impervious casings. Includes features, construction, and coding.—Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.

T-1043 **Precision Resistors.** 2-page Bulletin R describes "Series E" fixed noninductive wire-wound resistors. Covers features, applications, and specifications.—Hycor Co., Inc., 11423 Vanowen St., No. Hollywood, Calif.

T-1044 **Resistors and Rheostats.** 2-page September 1951 issue of "The Ohmite News" features illustrated article on application of maker's rheostats for creep-testing machine. Includes description of maker's resistors and rheostats.—Ohmite Mfg. Co., 4835 Flournoy St., Chicago 44, Ill.

T-1045 **Potentiometer-rheostats.** 4-page Catalog ST-L covers complete line of "Series L-400" precision wire-wound small potentiometers. Includes application.—DeJur-Amsco Corp., Industrial Div., 45-01 Northern Blvd., Long Island City 1, N. Y.

T-1046 **Electrolytic Capacitors.** 16-page Vol. 16, No. 10 issue of "The C-D Capacitor" features article on construction of grid-dip oscillator. Includes description of maker's capacitors and "Radio Trading Post."—Cornell-Dubilier Electric Corp., Hamilton Blvd., South Plainfield, N. J.

T-1047 **Decade Inductors.** Bulletin D describes "Series 700" decade-inductor units, including features and specifications.—Hycor Co., Inc., 11423 Vanowen St., No. Hollywood, Calif.

T-1048 **Toroid Coils.** 2-page Bulletin C describes high-Q toroid coils including features, applications, and specifications.—Hycor Co., Inc., 11423 Vanowen St., No. Hollywood, Calif.

T-1049 **Transformers.** 20-page illustrated Catalog TR-51 describes maker's large line of transformers for electronic equipment, including hermetically sealed, power, filter, vibrator, and isolation transformers. Includes specifications and applications.—Triad Transformer Mfg. Co., 2254 Sepulveda Blvd., Los Angeles 64, Calif.

T-1050 **Differential-transformer Positioners.** 4-page Engineering Data Folder No. 63 illustrates and describes micrometer positioners for positioning core of differential transformer. Includes applications and specifications. —Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Penna.

T-1051 **Connectors and Plugs.** 32-page illustrated handbook "Using the AN-"M" Connector" gives detailed instructions for installation, inspection, disassembly and reassembly operations. —Cannon Electric Advertising Dept., P.O. Box 75, Lincoln Heights Sta., Los Angeles 31, Calif.

T-1052 **Tubes.** 40-page "Tube Substitution Manual" includes general tube classifications, circuit modifications requiring additional resistors, substitution charts, adaptor circuits commonly required, and frequently-needed changeover diagrams.—Sylvania Electric Products, Inc., Emporium, Penna.

T-1053 **Oscilloscope Tube.** 2-page bulletin describes "12SP7" 12-in. cathode-ray tube. Covers operational data, maximum ratings and circuit values.—Tube Dept., Radio Corporation of America, Harrison, N. J.

T-1054 **Oscillator Triode.** 2-page bulletin describes "6026" subminiature oscillator triode. Includes electrical, mechanical, operating data and characteristics.—Tube Dept., Radio Corporation of America, Harrison, N. J.

T-1055 **Racks and Slides.** Catalog contains engineering drawings and specification sheets for maker's large line of slides and racks for consoles, chassis, drawers, etc.—Grant Pulley & Hardware Co., 31-85 Whitestone Pkwy., Flushing, N. Y.

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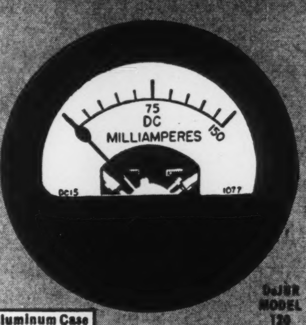

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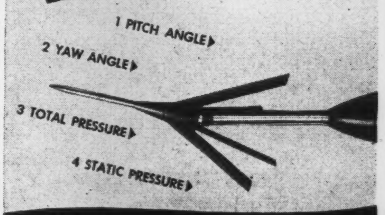

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T-1062 **Relays.** 4-page illustrated Bulletin MTR-24 describes "Series 80" line of midget telephone-type relays. Includes data on covers, characteristics, and specifications.—Signal Engineering & Mfg. Co., 154 W. 14th St., New York, N. Y.

T-1063 **Load Cells.** 4-page Engineering Data Folders illustrate and describe maker's load cells which use "Atcotran" differential transformers. No. 62 covers torsion-bar load cell; No. 65, cantilever-beam load cell. Include features and dimensions.—Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Penna.

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T-1066 **Power Supplies.** 4-page illustrated bulletin describes line of electronically regulated power supplies. Covers features and characteristics.—Lambda Electronics Corp., Corona, N. Y.

T-1067 **Motor-generators.** 8-page Bulletin 440 describes and illustrates 400-cycle motor-generators. Includes operation and application data. Covers voltage regulation, waveshape, and specifications.—Bogue Electric Mfg. Co., Paterson 3, N. J.

T-1068 **Transducer.** 8-page Bulletin 812 illustrates and describes new transducer which uses wire vibrating in a magnetic field as primary element for measuring process variables.—Rahm Instruments, Inc., 12 W. Broadway, New York 7, N. Y.

T-1069 **Fractional-hp. Motors.** 4-page Vol. 31, No. 6 issue of "The Bodine Motorgram" features articles on fractional-hp. motor application. Includes feature on characteristics of worm gears.—Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

T-1070 **Miniature Delay Lines.** 2-page Technical Bulletin DDL-51-8 illustrates and describes maker's miniature distributed-constant delay lines; covers applications, features, and table of characteristics.—PCA Electronics Inc., 6368 DeLongpre Ave., Hollywood 28, Calif.

Mechanical Components

T-1071 **O-rings.** Technical Data Sheet 102 describes maker's silicone-rubber O-rings, specially molded to allow for shrinkage; gives specifications for rubber and dimensions of rings.—Frederick S. Bacon Labs., 192 Pleasant St., Watertown 72, Mass.

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T-1073 **Springs.** 8-page October 1951 issue of "The Mainspring" features article on spring tolerances.—Associated Spring Corp., Bristol, Conn.

T-1074 **Springs.** 8-page Bulletin NS 500 "66 Hints to Simplify Design and Reduce Spring Costs" groups specific hints for purchasing, finishes, gages, etc. Includes table of spring materials and applications.—The Newcomb Spring Corp., 3902 Seventh Ave., Brooklyn 32, N. Y.

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T-1076 **Self-tapping Screws.** 48-page Catalog Form 600 "Parker-Kalon Engineering Standards" includes complete specifications on maker's large line of self-tapping screws, including proper selection and use.—Parker-Kalon Corp., 200 Varick St., New York 14.

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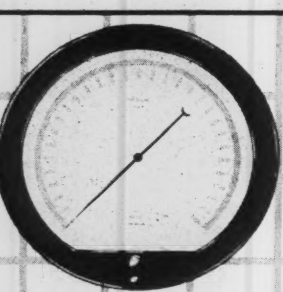

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Motor Control

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T-1084 **Heavy-duty D-c. Control.** 12-page Bulletin 206 presents new line of heavy-duty d-c. control equipment for mill use, including contactors, timers, switches, and relays.—Industrial Controller Div., Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

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T-1085 **Soldering Irons.** 4-page illustrated Form No. 105 describes hatchet, screw-tip, and plug-tip electric soldering irons. Covers characteristics, ranges, prices. Encloses 2-page Form 205 on additional screw- and plug-tip irons.—Hexacon Electric Co., Roselle Park, N. J.

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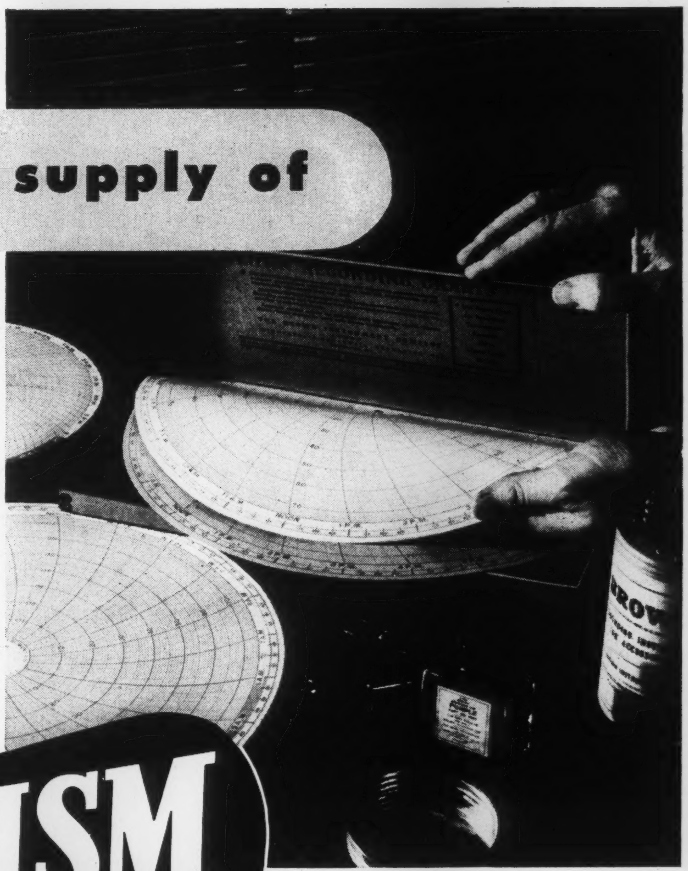

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THE 1952
Instruments Index
PART TWO OF THE
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What's more, you can get a permanent record of every phase of a process, isolating departmental processing and heating costs for more accurate cost accounting and detecting faulty operation of equipment.

If you aren't familiar with Taylor's new developments in automatic control, now is the time to look into them. Taylor's new TRANSET* System makes possible much closer control than anyone would have dreamed possible a short time ago . . . and new Taylor Instruments are now bringing amazingly high efficiency to almost every industry. Use Taylor Controls on all of your processes . . . the results will speak for themselves. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

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humidity, flow, liquid level,
load, speed and density.*

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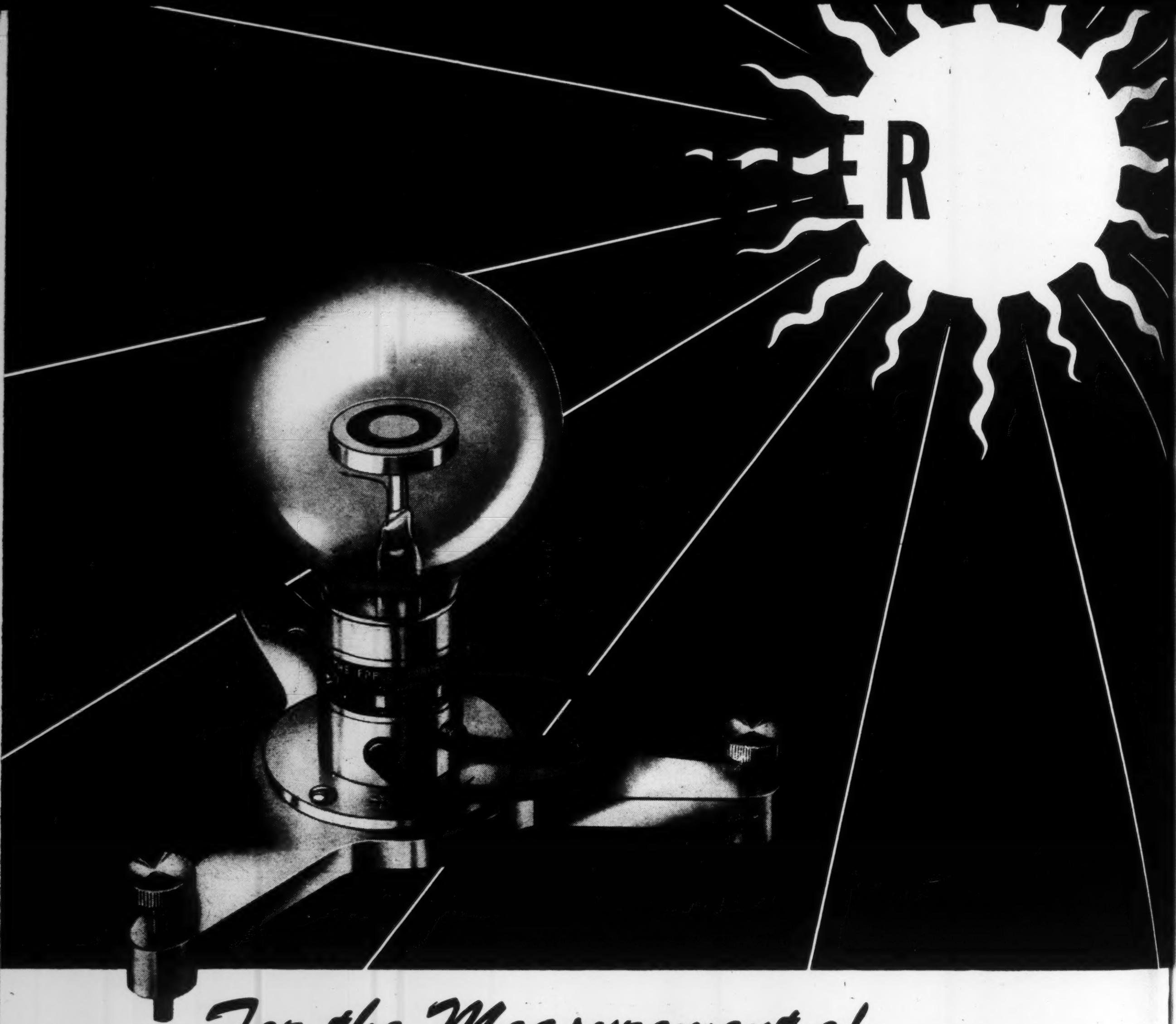

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Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau. The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

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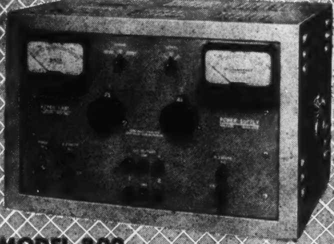
The supplies may be connected for series, parallel, or bucking operation.



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Model 800 features TWO INDEPENDENT REGULATED POWER SUPPLIES.
OUTPUT DC FOR EACH SUPPLY: 0-600 volts, 200 Ma. In parallel 400 Ma.
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REGULATION 0.1%

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FILAMENT SUPPLY: 6.3 volts AC, 10 Amp., CT

MODEL 315

B SUPPLY: 0-300 volts, 150 Ma.
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RIPPLE: 5 millivolts.
C SUPPLY: 0-150 volts, 5 Ma.
REGULATION: 10 millivolts for line 105-125 volts. ½% for load at 150 volts.
RIPPLE: 5 millivolts.
FILAMENT SUPPLY: 6.3 volts AC, 5 Amp., CT.
Available with Rack Mounting

MODEL 500-R

OUTPUT DC: 0-500 volts, 300 Ma.
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RIPPLE: 10 millivolts.
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Model 615 is the Model 500-R plus C supply

MODEL 245

OUTPUT DC: 200-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE VOLTAGE: 5 millivolts.
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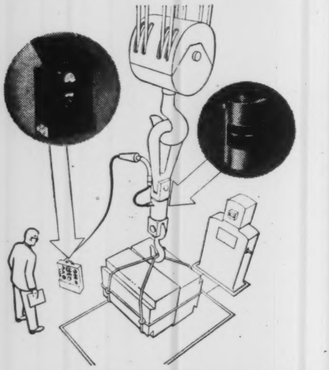


WEIGHT CALIBRATION OF LARGE PLATFORM SCALES

Mounting an SR-4 Load Cell in a crane hook permits continuing checks of platform scales to be made with minimum time and effort. Instead of shifting check-weights about the plant, any suitable bulky crane cargo can be utilized, by reading its weight on the electronic portable indicator, then comparing it with the weight registered by the platform scales.

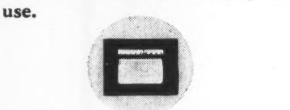
Other applications include the use of the SR-4 Crane Hook Mounted Unit for batch weighing . . . for a limit alarm to avoid crane overloading . . . and for the weighing of truck or rail shipments.

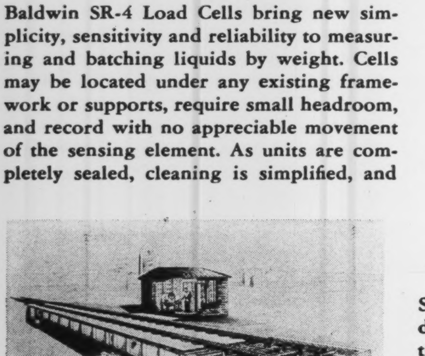
Baldwin SR-4 Load Cells have no moving parts, and are simple, rugged and durable. Accuracy is maintained over long periods of active use.

MULTI-TANK WEIGHING AND BATCH CONTROL OF LIQUIDS

Baldwin SR-4 Load Cells bring new simplicity, sensitivity and reliability to measuring and batching liquids by weight. Cells may be located under any existing framework or supports, require small headroom, and record with no appreciable movement of the sensing element. As units are completely sealed, cleaning is simplified, and any interference with accuracy because of corrosion or deposits is eliminated.

The indicating, recording or control instrument may be located at any convenient point, and used to report the weight of material in any number of tanks or hoppers. Savings in pitting and through the elimination of multiple parts bring cuts in cost.





TRACK SCALE FOR "DORMANT" AND "MOTION" CAR WEIGHING

Savings in first cost, a decrease in pit depth, reduced maintenance, and continuing accuracy are all among the advantages already recorded for track scales using SR-4 devices. Total vertical motion required for full load weighing is a matter of thousandths of an inch, permitting more rugged construction and lessening the effects of shocks during use.

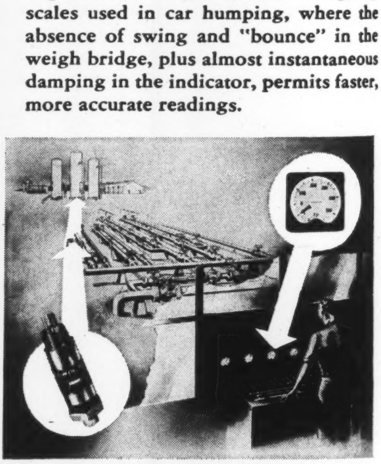
These advantages take on added importance in the "motion" weighing scales used in car humping, where the absence of swing and "bounce" in the weigh bridge, plus almost instantaneous damping in the indicator, permits faster, more accurate readings.

REMOTE PRESSURE MEASUREMENT IN OIL AND CHEMICAL PLANTS

Baldwin SR-4 Pressure Cells provide an accurate, economical means of measuring, controlling or monitoring fluids and gases. Cells may be placed at any desired location, and through electrical connections will "report-in" continuously to a remote central point. Another important application is in research, as the cells provide an unusually accurate means of measuring ultra-high pressures, surges, and explosion waves. Hysteresis and inertia effects are virtually abolished.

Tube material can be varied to meet a wide variety of pressure and corrosion conditions. Standard capacities are 200; 500; 1,000; 2,000; 5,000; 10,000; 20,000 and 50,000 psi.

A low-range series, with standard capacities of 10; 20; 50 and 100 psi, is also available.



Your own ingenuity will probably suggest many places where Baldwin SR-4 Load Cells and Pressure Cells can be used, cutting your manufacturing or processing costs. One of our representatives will be glad to give you full details on sizes and types available.

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The satisfactory functioning of a system of instrumentation and automatic control requires that the characteristics of each unit of equipment shall be correct for its particular service and that these characteristics shall be coordinated with those of all other related units.

The coordinated equipment developed by Hagan engineers includes pressure measuring and control devices for any range from a few thousandths of an inch water column to 5,000 psig; force measuring devices which will respond to the weight of a dime — or measure the total thrust of a jet bomber; panel type relay units which provide for modification of loadings and for remote manual control; double acting power units in sizes which provide precision control of tiny valves or of heavy slide dampers.

With such a variety of equipment, Hagan engineers can design the system which best meets the requirements of each individual application.

Certain types of installations, for example, are best served by mechanical metering units, with feeler lines connected direct to a self-contained recorder. The Hagan Ring Balance Flow Meter is designed particularly for this type of service.

Standard assemblies are made to measure flow differentials from ½ inch up to 420 inches WC, at static pressures as high as 15,000 psig.

These units may indicate, record and integrate one or two rates of flow. Addition, subtraction and compensation for temperature and pressure conditions may be included. Integration is maintained with high accuracy, even at the lowest flow rates.

Other types of installations may require that measuring elements be located near the primary device, sending pneumatic signals to recorders, as well as to control circuits. For this service, the Ring Balance Transmitter may be used at static pressures up to 15,000 psig and measuring maximum differentials as high as 420 inches WC.

Other types of units for translating pressure differentials into pneumatic signals are designed to serve as line type liquid meters or as differential measuring units in various ranges to a maximum pressure differential of 100 psi at static pressures up to 1,500 psig.

In all except the very simplest control systems, there is specific need for control mechanisms which can combine control signals. Some involve addition or subtraction of signals, while others involve multiplication, division, or even more complicated functions. The Hagan Ratio Totalizer is designed for almost universal application for accurately combining input control pressures and spring forces to produce a single pneumatic output control signal.

The Hagan THRUSTORQ, for translating mechanical forces into pneumatic signals for instrument or control circuits, fulfills the exacting requirements of aeronautical and similar testing laboratories.

Other Hagan Automatic Control units are designed for measurement and control of pressure, draft, temperature, engine or turbine speed, fuel-air ratio, damper or valve positioning, and the many other functions which may enter into the final solution of a particular problem.

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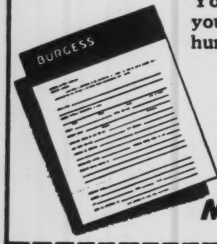

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THE 1952 INSTRUMENTS INDEX

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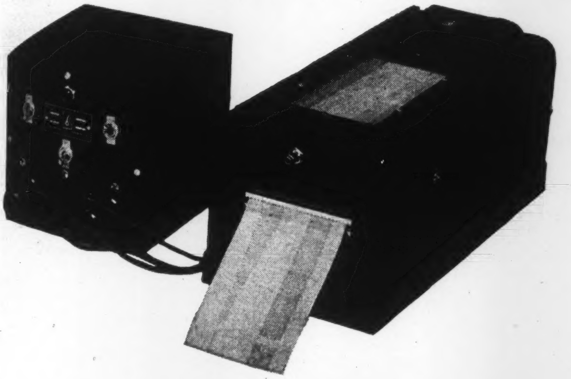


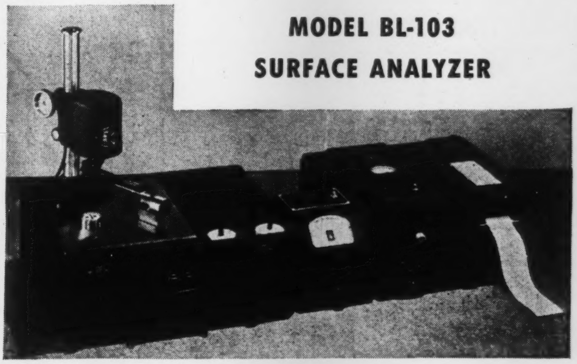
COMBINATION MAGNETIC OSCILLOGRAPH

The Model BL-221 Single Channel Magnetic Combination Oscillograph is similar to the Model BL-201 unit, except that circuit changes have been made to permit use of either a standard inking pen or an electric stylus. Magnetic penmotor Model BL-943 is used on the BL-221 Oscillograph and includes the proper connections for use of the electric stylus. A Power Supply, Model BL-944, furnishes voltage for the electric stylus operation. A switch on the front panel of the Power Supply permits the operator to increase the stylus voltage when recording high frequency phenomena. The main switch opens circuit to Power Supply to eliminate the possibility of receiving electric shock when handling stylus. Instruments are supplied with a standard pen and inkwell as well as the electric stylus. Oscillographs are available in single, double or six channel models with either inking pens or a combination of inking pen and electric stylus.

BL-932 D-C AMPLIFIER

Designed for use with the Brush Magnetic Direct Inking Oscillograph, and used to make recordings of many types of phenomena heretofore measured only with the aid of complicated intermediate equipment. Studies of such static or dynamic conditions as strains, displacements, pressures, light intensities, temperatures, d-c and a-c voltages or currents, and many others, are simplified by the use of the Brush Direct Inking Oscillograph with the BL-932 Amplifier. Voltage gain is sufficient to give one chart mm deflection per millivolt input. Novel design features reduce the effects of power line fluctuation. Zero signal drift amounts to not more than one chart mm per hour. Frequency response is essentially uniform from d-c to 100 cycles per second. The control panel at the front of the amplifier contains a factor-of-10 attenuator, gain control, calibrating meter, and controls for determining input voltages. A balancing potentiometer is provided for electrically biasing the oscillograph pen to any position on the chart. A rack mounted version of the DC Amplifier also is available as Model BL-962.

MODEL BL-103 SURFACE ANALYZER



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- **BL-121** Faxfilm Surface Comparator
- **BL-201** Single Channel Direct Inking Oscillograph
- **BL-202** Double Channel Direct Inking Oscillograph
- **BL-206** Six Channnel Magnetic Oscillograph
- **BL-221** Single Channel Combination Magnetic Oscillograph
- **BL-222** Double Channel Combination Magnetic Oscillograph
- **BL-309** Displacement Amplifier
- **BL-310** Strain Gauge Amplifier
- **BL-312** Universal Bridge Switch
- **BL-314A** Textile Uniformity Analyzer
- **BL-320** Universal Strain Analyzer
- **BL-905** AC Amplifier for use with Magnetic Oscillograph
- **BL-928** Dual Channel, Low Gain DC Amplifier
- **BL-932** D-C Amplifier
- **BL-933** Chart Takeup Drive, for use with BL-201, BL-202, BL-221, BL-222
- **BL-502** Transient Recorder
- **BL-301** Vibration Pickup, inertia type
- **DP-1** Vibration Pickup, displacement type
- **DP-1H** Heartbeat Pickup, similar to DP-1, with flat diaphragm
- **BL-962** D-C Amplifier, rack mounting
- **BL-809** Regulated Frequency Power Supply. Many accessories, such as time markers and slow speed drive kits for oscillographs.

ACOUSTIC AND TEST INSTRUMENTS*

- **BL-2301** Sound Level Recorder
- **BL-1011** Beat Frequency Oscillator
- **BL-4703** Frequency Response Tracer
- **BL-2002** Heterodyne Voltmeter
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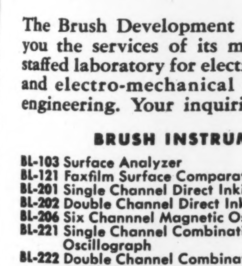

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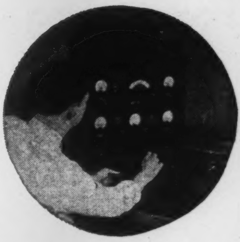
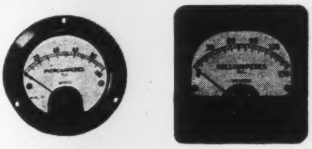
To do important measurement jobs Better... Quicker!

Model 697 VOLT-OHM-MILLIAMMETER One of a line of pocket-size meters, Model 697 combines a selection of a-c and d-c voltage, d-c current, and resistance ranges. Ideal for maintenance testing and many inspection requirements.



Model 686 ELECTRONIC TUBE ANALYZER tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, in accordance with manufacturers' rated operating conditions, or under desired operating conditions.



PANEL and SWITCHBOARD INSTRUMENTS—a complete line of instruments in all types, sizes and ranges required for switchboard and panel needs... including d-c, a-c power frequencies and radio frequency, rectifier types and D.B. meters.

Model 622 ULTRA-SENSITIVE INSTRUMENTS—portable d-c and a-c thermo instruments for precision measurement of potentials and minute currents in electronics or laboratory research.

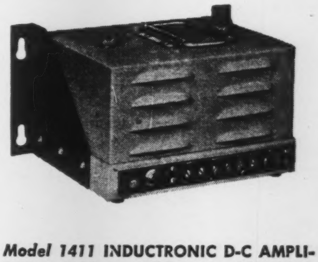
The same *dependability* evident in all WESTON standard instruments also is available in a broad line of *specialized* and *multi-purpose* instruments...all designed to do special and complex measurement jobs better, quicker, more economically. Whether for laboratory, shop or field requirements, first check instrument needs with WESTON. Consult the nearest representative, or write direct.

WESTON Instruments

WESTON Electrical Instrument Corporation
642 Frelinghuysen Avenue, Newark 5, New Jersey
Manufacturers of Weston and TAGliabue Instruments

SENSITIVE RELAYS—a line of sensitive relays including the Model 705 which provides positive control at levels as low as ½ microampere. Non-chattering magnetic contacts handle up to 10 watts at 120 volts.

Model 901 PORTABLE TEST INSTRUMENTS available in d-c, Model 901—and a-c, Model 904, single and multiple ranges of wide coverage. Excellent scale readability and shielding. Accuracy within ½ of 1%.



Model 1411 INDUCTRONIC D-C AMPLIFIER—stable amplifier provides high degree of resolution even at fractional loads. Reaches steady full scale deflection in fraction of a second. Interchangeable plug-in range standards for either microamperes or millivolts.

For Accurate

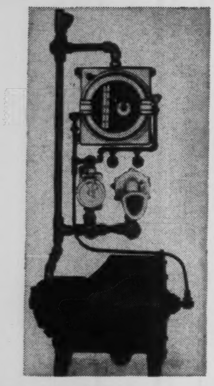
DETECTION MEASUREMENT CONTROL

of Industrial Atmospheric Hazards

Specify Dependable

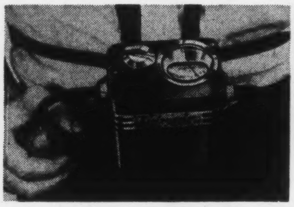
M·S·A INSTRUMENTS

COMBUSTIBLE GASES



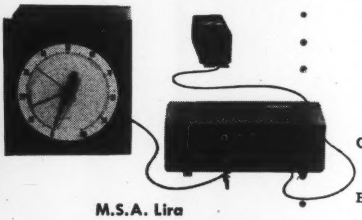
M.S.A. Combustible Gas Alarm

This widely-used instrument assures safe, continuous sampling of atmospheres for combustible gases and vapors. Its explosion-proof construction permits installation in hazardous areas. Visual and audible warning when concentrations exceed predetermined percentage of lower explosive limit. The Alarm may be wall mounted, if desired, and can be arranged for multi-point sampling with one instrument. Bulletin No. DT-6.



M.S.A. Explosimeter

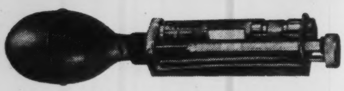
Accurate, one-hand operation for detecting and measuring flammable gas hazards and for locating gas leaks. Designed for day-in, day-out use. Compact, light weight, sturdy, easy to use. Meter is calibrated for easy reading. Ask for Bulletin No. DN-7.



M.S.A. Lira

This infra-red gas and liquid analyzer is ideal for measuring atmosphere contamination and for process control. It is extremely accurate, with rapid response to changing concentrations. Designed for permanent installation and continuous recording. Bulletin No. DZ-4.

TOXIC GASES



M.S.A. Carbon Monoxide Tester

Employing the most advanced colorimetric method of carbon monoxide detection, this accurate instrument will indicate CO in air from 0.001 to 0.10 percent by volume. Simple to use; requires no special training. Accurate in the presence of water and gasoline vapors. Bulletin No. BY-1.

M.S.A. Carbon Monoxide Alarm

Whenever carbon monoxide reaches a predetermined concentration, this precision instrument gives a prompt, loud warning and visible indication. Designed for 24 hour service, the unit is enclosed in a weather-proof case. Bulletin No. DR-2.

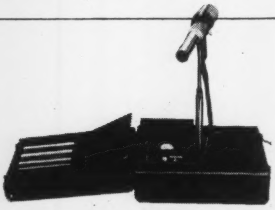
M.S.A. Hydrogen Sulfide Detector

Quick detection and accurate measurement of low but dangerous concentrations of hydrogen sulfide in air and process gases. Detects amounts ranging from 0.0025 to 0.04 percent by volume. Supersensitive models available for 0 to 50 p.p.m. Bulletin No. DY-3.

HARMFUL DUSTS

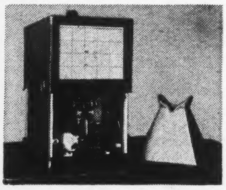
M.S.A. Midget Impinger

A compact, easy to operate intrument for obtaining accurate samples of particulate matter. Samples at the rate of 1/10 cubic feet per minute. Portable, self-contained, this unit is ideal for dust control and survey work. Bulletin No. CT-6.



M.S.A. Dust-Vue Microprojector

Permits rapid, easy counting of dust particles in collected samples, and particle size determination. Magnifies to 1000 times in size on ruled translucent screen—relieves eye-strain and permits greater accuracy. Bulletin No. CT-7.



M.S.A. Electrostatic Sampler

High efficiency in atmospheric sampling for all types of particulates including dust and fumes from molten metal and smoke. Features a portable head for sampling at various levels. Convenient to carry. Bulletin No. CT-9.

MINE SAFETY APPLIANCES COMPANY

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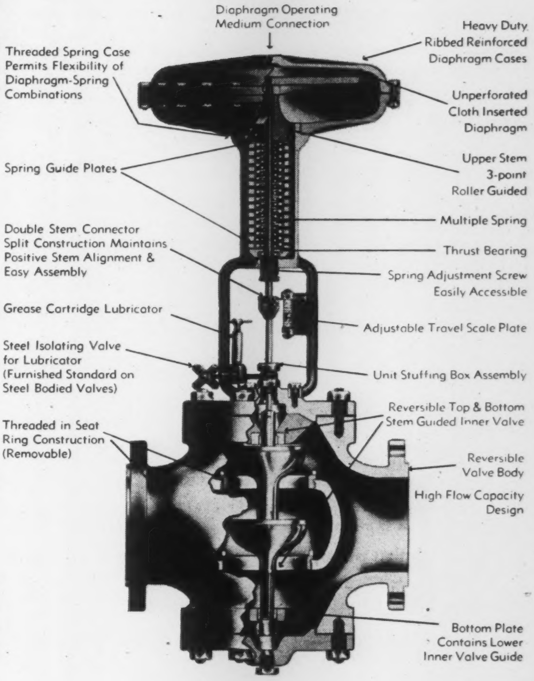
MSA SAFETY EQUIPMENT HEADQUARTERS

BLACK, SIVALLS & BRYSON, INC.

"Climax" Controls Division

BS&B "Climax" diaphragm control valves


Diaphragm Operating Medium Connection
Heavy Duty Ribbed Reinforced Diaphragm Cases
Threaded Spring Case Permits Flexibility of Diaphragm-Spring Combinations
Unperforated Cloth Inserted Diaphragm
Upper Stem 3-point Roller Guided
Spring Guide Plates
Multiple Spring
Double Stem Connector Split Construction Maintains Positive Stem Alignment & Easy Assembly
Thrust Bearing
Spring Adjustment Screw Easily Accessible
Grease Cartridge Lubricator
Adjustable Travel Scale Plate
Steel Isolating Valve for Lubricator (Furnished Standard on Steel Bodied Valves)
Unit Stuffing Box Assembly
Reversible Top & Bottom Stem Guided Inner Valve
Threaded in Seat Ring Construction (Removable)
Reversible Valve Body
High Flow Capacity Design
Bottom Plate Contains Lower Inner Valve Guide

TYPE 86 DIAPHRAGM CONTROL VALVE is used with instruments to control flow, temperature, pressure, and liquid level . . . to handle air, gas, vapor, steam or liquid . . . in all types of systems. It is designed with high lift characterized inner valves to obtain wide rangeability and constant proportional flow increase as valve opening increases with travel.

SPECIFICATIONS

Body size: Double port, 1/2" to 16". Single port, 1/2" to 4".

Body style: Screwed globe or flanged globe.

Pressure range: 125 to 5000 lbs. within body size limits.

Temperature: Up to 800° F.

Diaphragm pressure: 3 to 15 lbs., standard.

Material: Body—high tensile cast iron, electric cast steel, or special alloys. Trim—bronze or 18-8 stainless steel or special alloys.

When specific applications are desired, add the following letter or letters to the type number of the valve:

D: Direct acting valve (normally closed)
R: Reverse acting valve (normally closed)
DRT: Reverse topworks
H: Handwheel on diaphragm case (limits travel away from valve body)
M: Handwheel on lower body plate (limits travel into valve body)
F: Finned cooling section
PG: Purge gland section

When ordering, please specify: type, size, style, material, port design, inner valve design, diaphragm range, special appliances, maximum pressure, inlet pressure range, outlet pressure range, normal operating inlet-outlet pressure, and the volume, gravity, and temperature of the flowing medium through body.

specifications

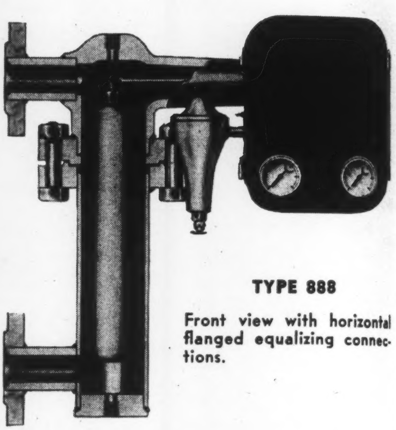
Type	Body Size	Body Style	Pressure Range	Temperature	Diaphragm Pressure	Material		Special Arrangements
						Body	Trim	
86	DP ½" to 16" SP ½" to 4"	Screwed Globe or Flanged Globe	125 lbs. to 5000 lbs. Within Body Size Limits	Up to 800° F.	3 lbs. to 15 lbs. Standard	High Tensile Cast Iron, or Electric Cast Steel, or Special Alloys	Bronze or 18-8 Stainless Steel or Special Alloys	-D, R. -RM, -DF -DFM, -RF, -RFM, -DH, -DRT, -RH, -DRTF, -DFH, -DPG, -RFH, -RPG, -DM, -DRTPG
15	SP 1", 1½" and 2"	Screwed Globe, Screwed Angle, and Flanged Angle	3000 lbs. 6000 lbs.	@ 100° F. @ 100° F.		Forged Steel, or Electric Cast Steel	Regular 18-8 Stainless Steel; Special Alloys on Request	-D -DRT -DF -DRTF
1515	¼", ⅜", ½" ¾" and 1"	Screwed Globe or Angle	3000 lbs.	@ 100° F.		Forged Steel, or Special Alloys	Stainless Steel; Special Alloys on Request	
1286	1" to 8"	Three Way Control	125 to 600 lbs. Pressure Drop Limited	Up to 800° F.		High Tensile Cast Iron and Cast Steel or Special Alloys	Stainless Steel and Bronze or Special Alloys	
73	DP ½" to 16" SP ½" to 4"	Screwed and Flanged Globe, Can be loaded directly or through a pressure pilot	125 to 5000 lbs. Within Body Sizes	Up to 800° F.	Maximum 50 lbs.	High Tensile Cast Iron or Electric Cast Steel and Special Alloys	Bronze or 18-8 Stainless Steel or Special Alloys	

For further information on BS&B "Climax" Diaphragm Control Valves, write for Catalog Section 105.

BLACK, SIVALLS & BRYSON, INC.

BS&B "Climax" displacement liquid level controllers

The Climax Type 888 Controller is recommended for all types of liquid level control applications involving exacting and wide range control. It utilizes torsion tube assembly for transmitting level changes . . . eliminates objectionable packing glands and pressure type bearings. It is designed for control of levels from minimum variations of ¼" up to "wide range" variation of 120 inches. It operates on liquid specific gravities ranging from .05 to 2.0 with standard displacement elements.



TYPE 888

Front view with horizontal flanged equalizing connections.

FEATURES

Torque tube is adjustable and easily replaced. Torque tube housing is removable and reversible in the field. Two torque tubes can be used on a single unit.

Cone point and connector are rugged, friction-free, and easily replaced. Includes a new single point cone suspension pivot.

Long displacement arm and long heavy torque tube combine to provide long life and greater accuracy of control. Displacement element is of heavy wall steel tube with dished caps welded into ends for long life and high pressures.

Element cage has been reduced in size but heavier walls and smaller flanges greatly increase the safety factor of the controller.

APPLICATIONS

1. For "inter-face" or "duo-gravity" level control of two non-miscible liquids of different specific gravities.
2. For specific gravity control or indication where liquid densities may be maintained within range of the controller.
3. For indication of liquid level positions where handling corrosive liquids, or at remote points on vessels not easily visible for observation of sight glasses.
4. To indicate full range level position when used with Type 1400 pilot.
5. To reset "rate of flow" controllers.
6. For safety alarm or shutoff.
7. For dual pilots. Two torque tubes with appropriate pilots and switches can be used with a single controller.
8. For "on-off" valve operation.

TYPES 887 and 889 Controllers are internal mounted and recommended where corrosive conditions preclude the use of external piping. Construction details are same as Type 888 except that no cage is included and provisions are made for positioning the displacement element at the required level in the vessel.

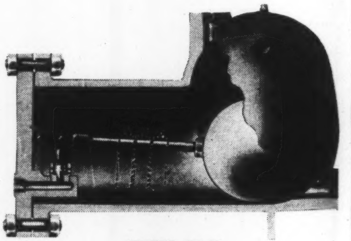
For further information on BS&B "Climax" Displacement Liquid Level Controllers, write for Catalog Section 103.

BS&B "Climax" continuous drainers

Climax Continuous Drainers are designed for duo-phase or duo-gravity draining of water, condensate or oils. When inverted, they can be used as vent traps.

The bodies are constructed of semi-steel or cast steel. Float is of stainless or nickel-plated steel. Other metals or alloys available upon request. The float movement is transplanted to the inner valve by means of the toggle attached to the float rod toggle. BS&B also manufactures internal float and drainer assemblies.

The head plate valve and float assembly of some types can be furnished alone for use on vessels or tanks equipped with an 8-inch nozzle to match the head drilling.



TYPES 90-91

TYPES 90 DUO-PHASE and 91 DUO-GRAVITY. Equalizing connections: 1" or 1½". Outlet: ¾". Float: 7¾" diameter*. Orifice: 1/16" to ¾". Working pressure: Cast iron, 150# @ 350° F. Cast steel, 500# @ 450° F. Especially adaptable for use as steam traps.

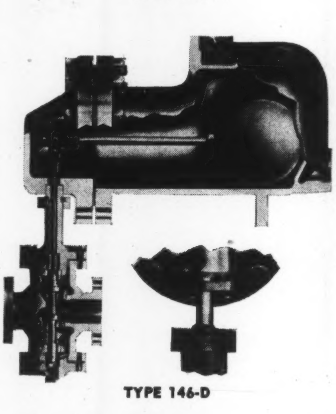
TYPES 140 DUO-PHASE and 141 DUO-GRAVITY. Equalizing connections: 1½" or 2". Outlet: 1". Float: 7¾" diameter*. Orifice: 1/16" to ⅞". Working pressure: Cast iron, 250# @ 460° F. and 400# @ 100° F. Cast steel, 300# @ 800° F. and 600# @ 100° F.

TYPES 440 DUO-PHASE and 441 DUO-GRAVITY. Equalizing connections: 1½" or 2". Outlet: 1". Float: 7¾" diameter*. Orifice: 1/16" to ⅞". Max. working pressure: Up to 1500# @ 100° F. if the required drainer orifice is not so large that differential pressure against the closed valve cannot be overbalanced by float buoyancy.

TYPE 146-D. Valve body size: ½" to 2" screwed globe, and 1½" and 2" flanged globe. Float: 7¾". Equalizing connections: 1½" or 2" NPT. Maximum working pressure: 1000# @ 100° F. or rating of valve body. Utilizes drainer body and float construction of Type 140 with a complete valve body connected to the float arm through a swivel coupling for handling larger volumes of flow.

* Floats 91, 141, and 441 are weighted to sink in liquid of gravities higher than 40° API (.825 Sp. Gr.) and float on water.

For further information on BS&B "Climax" Drainers or Vent Traps, write for Catalog Section 101.



TYPE 146-D

"Climax" Controls Division

BS&B "Climax" self-operated regulators

TYPE 96 D/R SIMPLEX PRESSURE BALANCE DIAPHRAGM REGULATOR

The Type 96 Regulator is recommended for exacting temperature control applications. It is used with temperature controllers where a design permitting reset of position of inner valve with minimum friction or hysteresis is required to give sensitivity control in the highest degree. It is also used with pressure controllers for reducing or back pressure service.

CONSTRUCTION

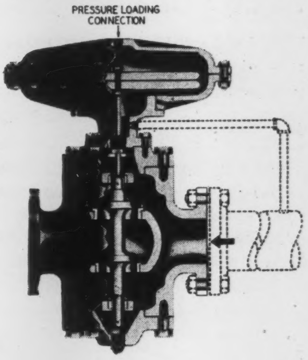
Standard construction includes high tensile cast iron or cast steel body, bronze or 18-8 stainless steel trim, quick opening double port, top and bottom guided metal seat inner valves. Heat treated stainless or composition inner valves may be furnished on special order. Bodies and trim are fully reversible, making it possible to convert a direct to a reverse acting regulator and vice versa without additional parts.

Sizes: 1/2" to 2" screwed globe. 1" to 10" flanged globe (ASA).

Maximum inlet pressure: 300#.

Controlled pressures: 4" water to 25#.

Maximum temperature: 150° F. or 450° F. with fins.


PRESSURE LOADING CONNECTION

TYPE 77 REDUCING REGULATOR

The Type 77 Regulator is designed for supersensitive pressure control. It is recommended for engine fuel pressure control, Channel Black burner pressure control, and other pressure control services requiring the highest degree of sensitivity. It is pilot loaded, pressure balanced, and diaphragm actuated.

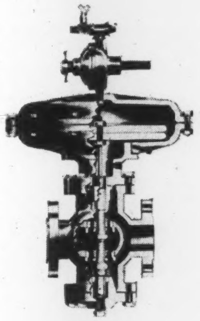
Standard construction is same as Type 96 D/R.

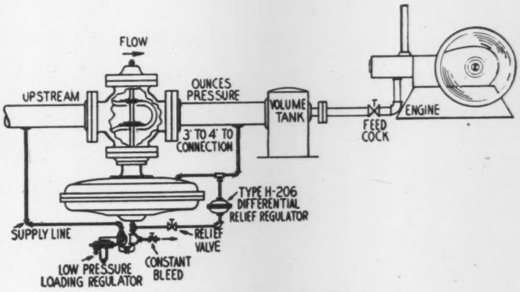
Sizes: 1/2" to 2" screwed globe. 1" to 10" flanged globe (ASA).

Maximum inlet pressure: 100#.

Controlled pressures: 2 to 25#.

Maximum temperature: 150° F.



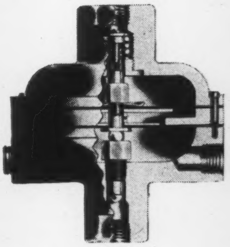

FLOW
UPSTREAM
OUNCES PRESSURE
VOLUME TANK
FEED COCK
ENGINE
3' TO 4' TO CONNECTION
TYPE H-206 DIFFERENTIAL RELIEF REGULATOR
SUPPLY LINE
RELIEF VALVE
LOW PRESSURE LOADING REGULATOR
CONSTANT BLEED

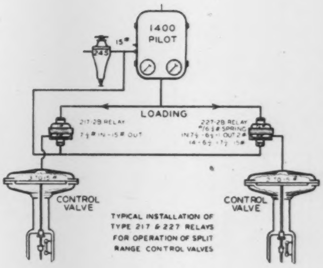
Type 77 — Installation Diagram

BS&B "Climax" relay regulators

TYPE 227 DELAYED ACTION RELAY, FIXED RATIO

Type 227 Relays are designed primarily for use with diaphragm control valves when they are required to operate in series: i. e. through "split range." By use of one or more Type 227 relays with a Type 217 relay, control valves with a standard range (3 to 15 lbs.) can be fully travelled with primary control pressure changes as low as two or three pounds. A typical installation of this relay applied to split range valves is shown at the right.




1400 PILOT
245
15#
LOADING
217-28 RELAY
7½# IN - 15# OUT
227-28 RELAY
#/6½# SPRING
IN 7½ - 6½ - 1 OUT 2#
14 - 6½ - 7½ 15#
3 TO 15#
3 TO 15#
CONTROL VALVE
CONTROL VALVE
TYPICAL INSTALLATION OF TYPE 217 & 227 RELAYS FOR OPERATION OF SPLIT RANGE CONTROL VALVES

Through its various diaphragm assemblies, The Type 227 Relay offers a selection of ratios—1:1, 1:2, 2:1, 1:3, 3:1, 1:4, 4:1 — to meet demands of control pressures beyond the range of usual instrument pressures.

Standard construction: body and diaphragm casing: cast bronze. Inner valve assembly: stainless steel. Diaphragms: Oil-resistant Neoprene. Incorporated in the relay is a spring of sufficient power to delay opening of the output port until a certain fixed loading pressure has been reached. This fixed spring loading is permanently absorbed and only loading pressures above the pressure absorbed by the spring will affect the relayed ratios.

All pipe connections are 1/4" NPT.

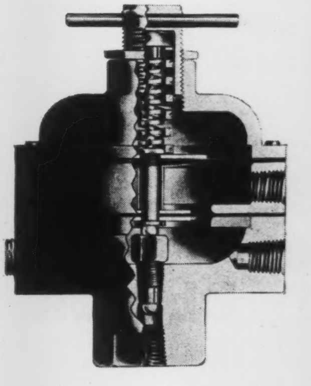
Maximum supply pressure is 200#.

TYPE 228 REVERSE ACTION RELAY

Type 228 Relay is used for delivering maximum pressure output at minimum pressure input from pilot or other controlling source—or vice versa—without modification of any kind in either pilot or valve hookup.

If reversal of valve closure in relation to pilot action is required from time to time, installation of this relay in a bypass line will provide a simple, fast, and inexpensive method of accomplishing the change.

Standard construction includes, case, top, and non-wearing parts of bronze. Ratio plates, inner valve and seats are of stainless steel. Diaphragms are of nylon-inserted neoprene.
Connections: 1/4" NPT. Range: 2 to 30#.



"Climax" Controls Division

BS&B "Climax" pressure controllers

TYPE 1400 PRESSURE CONTROLLER (Non-recording) handles both positive an negative pressures—from high vacuum to 10,000#. Bourdon tube operated, Type 1400 is suited for operations requiring highest sensitivity or where throttling ranges are necessary to dampen sensitivity. Type 1400 overcomes cyclic or hunting action where conditions make "lined-out" pressure control difficult.

This controller is also suitable for vacuum relief control, vacuum control, fluid pressure control, boiler steam pressure control, off-and-on control, and snap-action where the two limits may each be set at any desired pressure up to 25% of Bourdon tube rating.

Range: Vacuum to 10,000# working pressure.

Throttling Range: Adjustable 0-200 per cent.

Available Bourdon Tube Ratings in Lbs.: 30, 60, 100, 300, 500, 750, 1000, 1500, 2000, 3000, 5000 and 10,000.

For further information on BS&B "Climax" Pressure Controllers, write for Catalog Section 110.

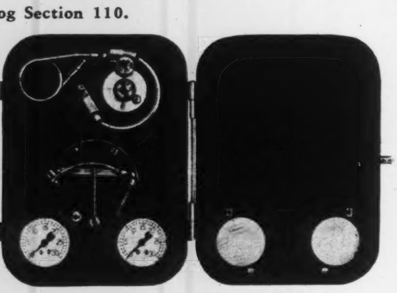
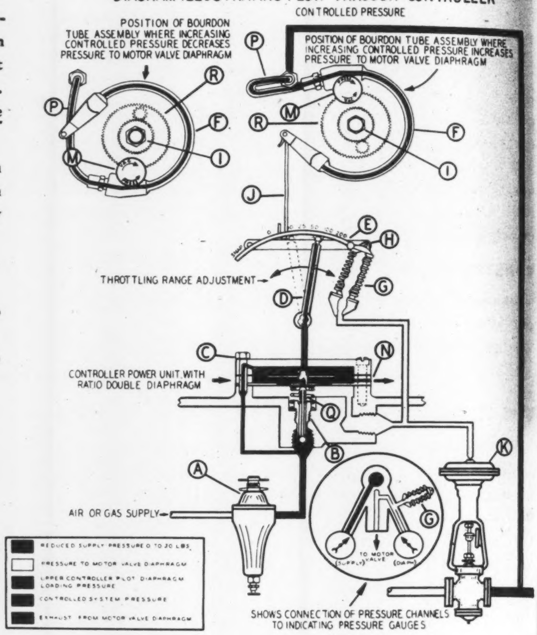


DIAGRAM ILLUSTRATING FLOW THROUGH CONTROLLER


CONTROLLED PRESSURE
POSITION OF BOURDON TUBE ASSEMBLY WHERE INCREASING CONTROLLED PRESSURE DECREASES PRESSURE TO MOTOR VALVE DIAPHRAGM
POSITION OF BOURDON TUBE ASSEMBLY WHERE INCREASING CONTROLLED PRESSURE INCREASES PRESSURE TO MOTOR VALVE DIAPHRAGM
P
R
F
M
I
J
E
H
G
D
THROTTLING RANGE ADJUSTMENT
0
10
25
50
100
200
C
N
CONTROLLER POWER UNIT WITH RATIO DOUBLE DIAPHRAGM
Q
B
A
K
AIR OR GAS SUPPLY
TO MOTOR VALVE
SUPPLY
DIAPH
SHOWS CONNECTION OF PRESSURE CHANNELS TO INDICATING PRESSURE GAUGES
REDUCED SUPPLY PRESSURE 0 TO 30 LBS.
PRESSURE TO MOTOR VALVE DIAPHRAGM
UPPER CONTROLLER PILOT DIAPHRAGM LOADING PRESSURE
CONTROLLED SYSTEM PRESSURE
EXHAUST FROM MOTOR VALVE DIAPHRAGM

BS&B "Climax" auxiliary regulators

TYPE 245 SUPPLY MEDIUM REDUCING REGULATOR

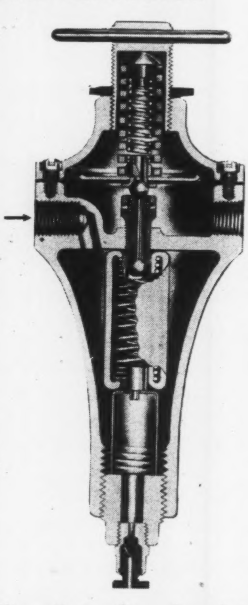
The Type 245 Regulator features an integral strainer and a relief valve in the diaphragm. Dual loading springs give sensitive control at both high and low settings within the specified control range. The regulator is standard equipment on all BS&B Pressure Pilots, Level Control Pilots, and Time Cycle Controls unless otherwise specified.

MATERIALS

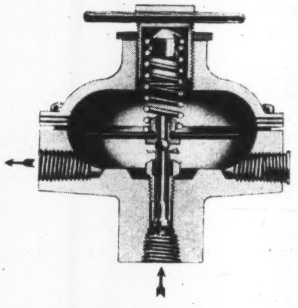
Body and cap: Cast aluminum.
Inner valve assembly: Stainless steel.
Diaphragm backup plate: Stainless steel.
Diaphragm: Neoprene.
Springs: Cadmium-plated steel.

SPECIFICATIONS

Size ¼".
Maximum Inlet Pressure: 300#.
Reduced Pressure Range: 2 to 50#.
(Special springs available for higher reduced pressure ranges.)
Volume Sediment Chamber: 6.3 cubic inches



TYPE 216 PILOT SUPPLY REDUCING REGULATOR



TYPE 216 REGULATOR is designed without the strainer-drip chamber and has a large diaphragm area for sensitive control pressures. It is extensively used on diaphragm actuated-pressure loaded regulators as the loading regulator or "pilot", and may be used in any service requiring accurate control within ranges specified.

SPECIFICATIONS

Size: ¼".
Maximum Inlet Pressure: 300#.
Reduced Pressure Range: 2 to 30#.

For further information on BS&B "Climax" Auxiliary Regulators, write for Catalog Section 107

BLACK, SIVALLS & BRYSON, INC.

15 N. Cincinnati St., Tulsa, Oklahoma

alnor POINTS with PRECISION

Constant Millivolt Characteristics

over a wide range of ambient temperatures are assured by a high manganin to copper ratio plus a series negative temperature coefficient resistor. Automatic cold end compensator adjusts for changes in ambient temperature during a test.

Low Contact Resistance

The selector switch is of heavy duty construction designed for a low and constant value of contact resistance . . . of prime importance when high accuracy is required. Multi-point switch is housed in separate compartment in the case which also contains a high grade mercury in glass thermometer.

Direct Reading

Just turn the switch to the desired circuit and read the temperature directly—no balancing operations or conversion charts. Large 6" scale face is easily and quickly read. Knife edge pointer and mirror eliminate parallax errors. Single or double scale ranges available. Illinois Testing Laboratories, Inc., Rm. 518, 420 N. La Salle St., Chicago 10, Illinois

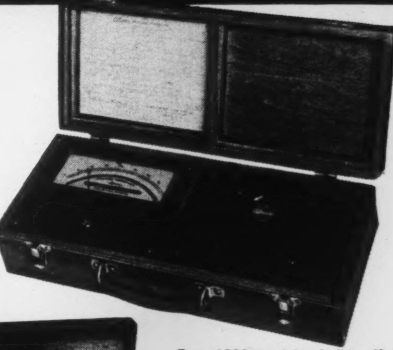
Overlapping Contacts

When switching from one circuit to another, the new circuit is made before the old is broken . . . the meter circuit is never opened during switching, thus eliminating the possibility of damage due to excessive and wild pointer swing.

portable multi-circuit Pyrometer

Combining portability with precision laboratory performance, Alnor Portable Multi-Circuit Pyrometers make possible accurate temperature measurement at a multiplicity of points in rapid succession. Type 1200 Pyrometer is particularly valuable in reading temperature rise of various portions of an electrically operated device or repetitive tests on a production run of closely controlled units.

Featuring modern design and rugged construction throughout, Alnor Pyrometers have precision-built double air gap movements of exceptionally high internal resistance . . . famous Alnico magnets . . . the finest in sapphire bearings and hardened steel pivots. Ask your Alnor representative for complete details and prices on these accurate and reliable instruments.



Type 1200 precision-built, self-contained, portable that gives instant, accurate readings of temperatures at a number of points in rapid succession. Available with 8 or 17 circuits. Scale ranges from 0-300° to 0-3000° F. and their centigrade equivalents.

Type 1000 Portable Resistance Thermometer with 8 circuit switch for low temperature service. Available in a variety of ranges between —100° F. and +400° F. A span as small as 50° F. can be supplied.

ILLINOIS TESTING LABORATORIES, INC.

alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

Illinois Testing Laboratories, Inc.
Room 518, 420 N. LaSalle St., Chicago 10, Ill.

☐ Send Bulletin. ☐ Have an Alnor representative call.

Name...

Company...

Address...

City.............................Zone....State.........

Century INDUSTRIAL

FOR VIBRATION, STRESS, TEMPERATURE,

MODEL 408 OSCILLOGRAPH

The Century Model 408 recording oscillograph was designed expressly for airborne and mobile operation. As with all Century products, this oscillograph incorporates the utmost in design and workmanship, along with improved features, yet it remains simple in its operation and maintenance.

FEATURES:

Size: 20" long, 12½" wide, 8⅞" high.

Weight: 51 pounds.

Number of Recording Channels: 6 to 48.

Detachable daylight loading magazine accommodating a roll of paper or film 8" x 200'.

Friction roller type paper drive by governor controlled electric motor with separate motor for takeup drive.

Paper speeds continuously and instantly variable without changing gears or sprockets.

Separate optical system for viewing before or during recording.

Glow tube timing system photographing .01 second and .1 second lines. .01 second lines instantly removable by toggle switch for slower speeds.

Data numbering at beginning of record.

Footage indicator showing amount of paper remaining in magazine.

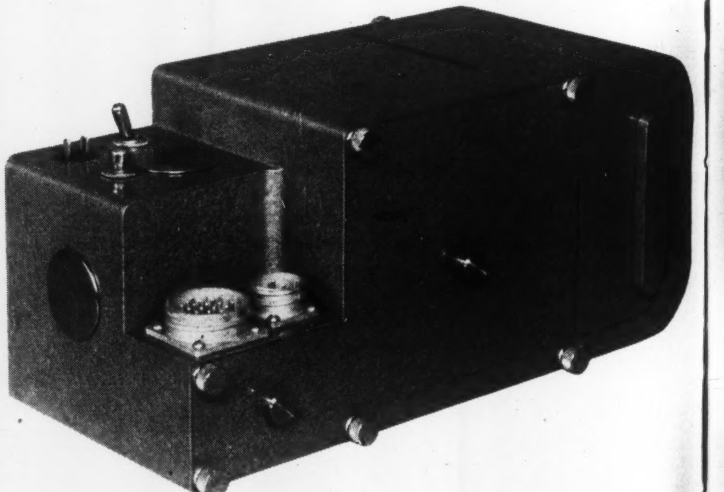
Automatic record length control.

Trace identification.

Remote control unit.

MODEL 409 OSCILLOGRAPH

The Century Model 409 oscillograph has been designed for recording data where space and weight requirements are limited. This oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.



FEATURES:

Size: 5" x 5" x 11".

Weight: 11 pounds.

Cast Aluminum case.

Paper speeds instantly variable ½" to 6" and 2" to 12" per second.

Detachable daylight loading magazine with a capacity of 3⅝" x 50' or 3⅝" x 100' paper. 2 to 12 individual channels.

Trace identification.

Trace viewing.

RECORDING EQUIPMENT

STRAIN ANALYSIS, and other Applications

MODEL 406 OSCILLOGRAPH

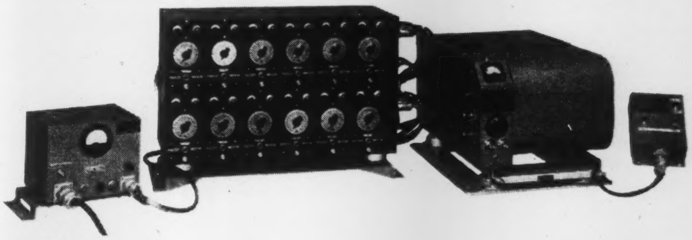
The Century Model 406 oscillograph is one of the finest laboratory instruments available. This unit will accommodate up to 48 individual channels and still incorporates all of the preferred features.

FEATURES:

- Size: 12½" x 13½" x 22".
- Weight: 90 pounds.
- Continuously variable speed control without gear change.
- Temperature compensated fork controlled timing system using a glow tube.
- Separate paper takeup magazine allowing any length of recording up to 200 ft. without jamming.
- Magazine capacity of 8" x 200' roll of paper or film.
- Separate optical system for trace viewing and scanning.
- Automatic record numbering at beginning of record.
- Paper footage indicator.
- Automatic record length control.
- Remote control unit.
- Available for 24 volt d.c. or 115 volt a.c. operation.

MODEL 508 LINEAR-INTEGRATING AMPLIFIER

With Power Supply, Model 408 Oscillograph and Remote Control



FEATURES:

- Frequency response flat ± 5% from 3 cps to 3,000 cps or ± 2% from 5 cps to 2,000 cps.
- Frequency response linear ± 5% from 5 cps to 2,000 cps or ± 2% from 7 cps to 2,000 cps.
- Individual output metering.
- Overload indicator.

GALVANOMETERS

All Century oscillographs are equipped with Century Model 210 galvanometer elements. These elements are available over a wide range of frequencies and sensitivities and in most instances are easily adaptable to other makes of oscillographs. Each element is electrically isolated.

FEATURES:

- Small, tubular type construction with rotating pole pieces flush with case. This allows correct flux angle for any horizontal position and eliminates stressing the suspension for horizontal adjustment.
- Hermetically sealed.
- Horizontal and vertical optical adjustment readily accomplished.
- Plug-in mounting, elements may be replaced or interchanged with minimum effort.
- Negligible zero drift as a function of temperature.

Century GEOPHYSICAL CORPORATION
TULSA, OKLAHOMA

1505 Race Street
Philadelphia, Pa.

EXPORT OFFICE:
149 Broadway, New York

HEAD CUSTOMB

DYNA-MYKE
Model 129

DYNA-METER
Model 144

UNI-BRIDGE
Model 128

Sign of
ADVANCED INDUSTRIAL INSTRUMENTATION

- Measuring
- Indicating
- Recording
- Controlling

DYNA-MYKE Model 129—A high speed dynamic micrometer capable of indicating displacements as small as 1 micro-inch at frequencies as high as 1000 cps. The system indicates, controls and records, using either differential transformer or strain gages.

DYNA-METER Model 144— When used with the DYNA-MYKE, indicates by neon lights the peak amplitude of transients as fast as 1 Millisecond. Indication may be instantaneous or a memory feature may be used to maintain reading. Built-in power relays provide on-or-off control to any plus or minus limits established by DYNA-MYKE.

UNI-BRIDGE Model 128—Universal DC power supply and bridge control system. Contains micro-ammeter, balancing and calibrating circuits, output jack and chopper.

CALI-POWER AC Model 132—A precision source of calibrated AC voltage. Provides 10 watts of power in full scales, ranges of 1 millivolt to 100 volts.

CALI-POWER DC Model 145—A precision source of calibrated DC voltage. Provides 10 watts of power in full scales, ranges of 10 millivolts to 100 volts. Like Model 132, AC, used for driving and calibrating amplifiers, voltmeters, resistance bridges, transducers, penmotors, galvanometers, etc.

CALI-BRIDGE Model 134—Combines CALI-POWER DC with the UNI-BRIDGE. A more versatile instrument for signal calibration, as well as for bridge control purposes.

THE USE OF THESE INSTRUMENTS can reduce manpower and eliminate causes of scrap at the source. Examples: measuring and indicating press vibration, micro-inch surface finish; indicating and controlling hydraulic or pneumatic pressure; measuring structural or metallic creep; gaging and controlling thickness of metals, plastics and fabrics.

Applications

LINEAR VARIABLE DIFFERENTIAL TRANSFORMERS for minute displacements. Employed as the sensing element in the DYNA-MYKE, which is designed for use with commercially available pickups, accelerometers, transducers, etc. Fig. 1.

STRAIN GAGES for use with the UNI-BRIDGE, CALI-BRIDGE, and DYNA-MYKE self-contained instruments for all types of gaging and recording. Fig. 2.

ACCELEROMETERS for all ranges and natura frequencies, in miniature. Weight less than ½ ounce. Indicating, recording and controlling by DYNA-MYKE and DYNA-METER.

SURFACE FINISH GAGE HEADS, Standard and Custom Built, employing differential transformers as sensing element. Measuring, indicating, recording and controlling by DYNA-MYKE and DYNA-METER. Fig. 4.

VIBRATION PICKUP for direct reading of displacements as small as ±1 micro-inch at frequencies from zero to 1000 cps. Fig. 5.

PRESSURE PICKUP for hydraulic or pneumatic application, custom built to you specifications. Fig. 6.

CONTROL BOX balancing network for us with UNI-BRIDGE, CALI-BRIDGE, or DYNA-MYKE, using either strain gages or differential transformers. Fig. 7.

SELECTOR SWITCH controlling as many as ten channels of measurement with one Selector Switch, ten Control Boxes, and one UNI-BRIDGE, CALI-BRIDGE or DYNA-MYKE. Fig. 8.

SCALE with sensitivities of one part in 10,000, using DYNA-MYKE system. Unlimited range. Fig. 9.

AND INFALLIBLE QUALITY CONTROL adaptable to most processes. Automatic precision inspection *on the machine* with DYNA-MYKE; instant acceptance, rejection, appropriate action when teamed up with DYNA-METER.

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BUILT INSTRUMENTS

OWER
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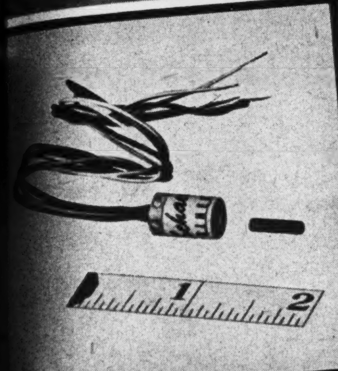
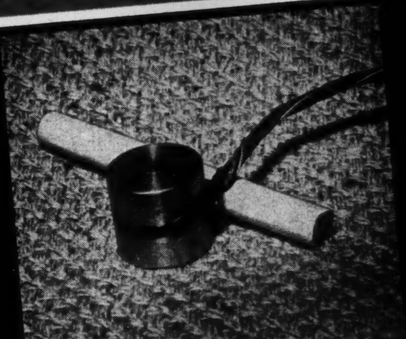
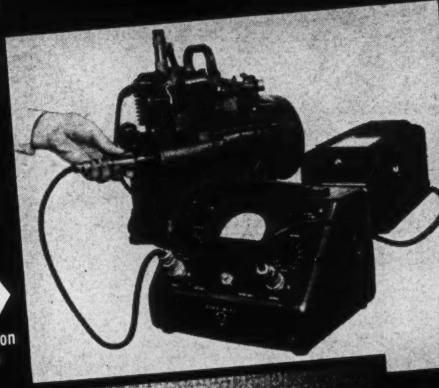
CALI-POWER
DC Model 145
CALI-BRIDGE Model 134

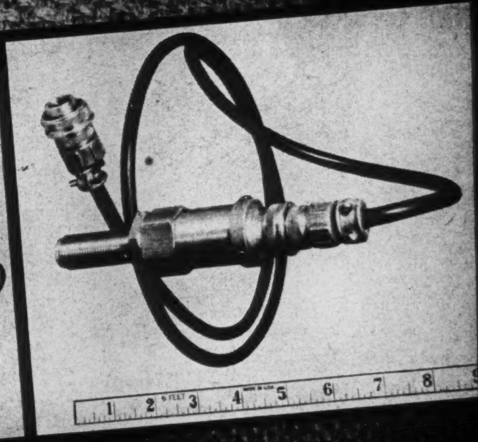

1. Linear Variable Differential Transformer

2. Strain Gages


3. Accelerometer

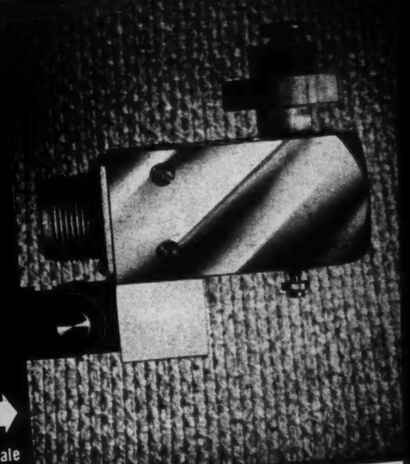
4. Surface Finish Gage Head


5. Vibration Pickup

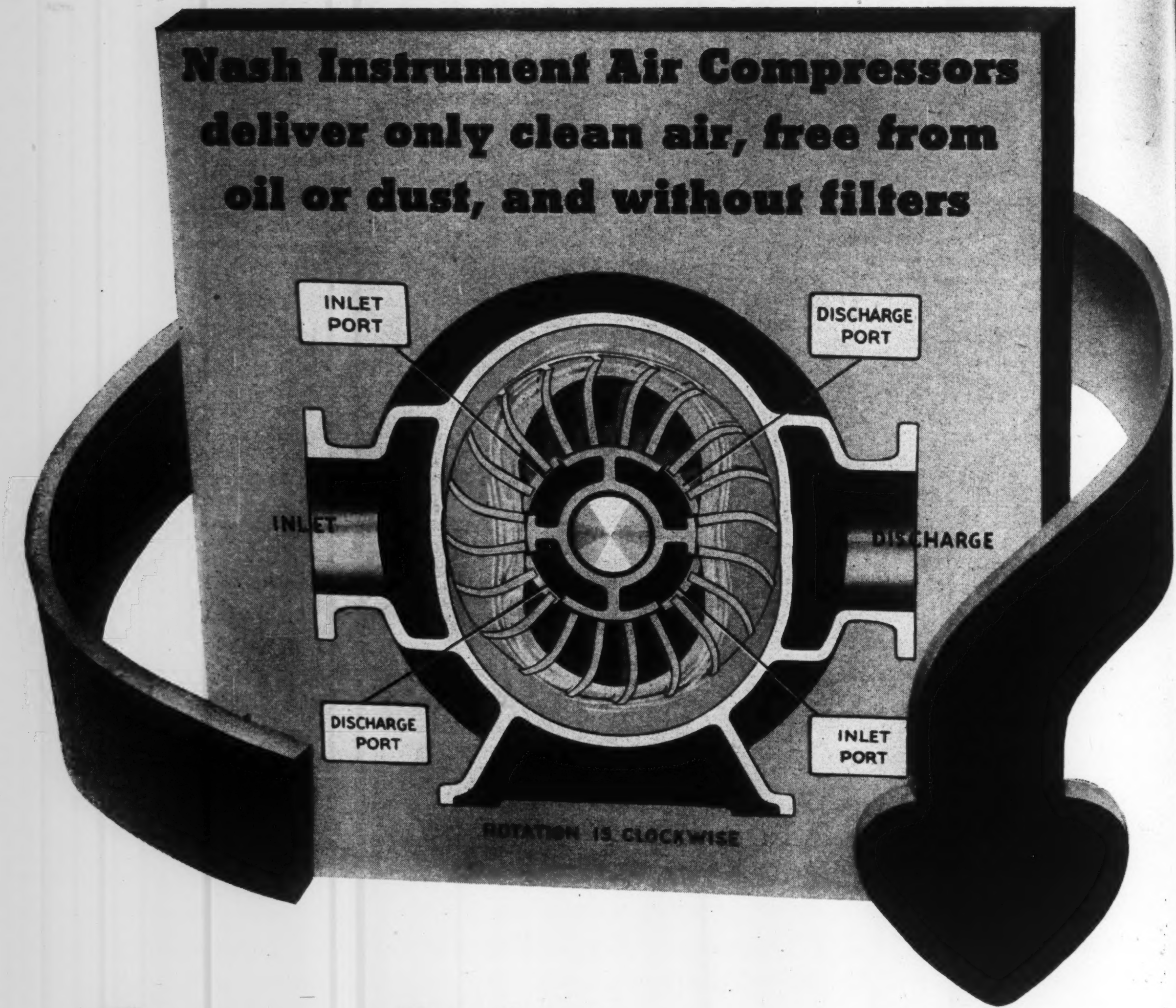

6. Pressure Pickup

7. Control Box

8. Selector Switch


9. Scale

INDUSTRIAL ELECTRONICS, INCORPORATED
8082 WHEELER STREET • DETROIT 10, MICHIGAN


Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
INLET
DISCHARGE
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

MEASUREMENT AND CONTROL DEVICES FOR

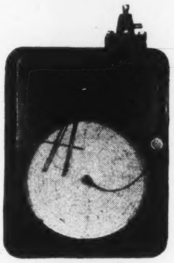
Gases • Oil • Steam • Air • Liquids

Trade Names: AMERICAN • RELIANCE

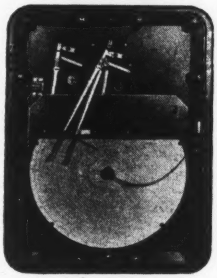
PRODUCTS Meters: Demand, Displacement (Gas or Air), Flowmeters, Indicating, Integrating, Recording, Laboratory, Orifice, Oxygen, Prepayment, Wet and Dry Test, Wide Range Orifice, etc. INDEXES: Base Pressure, Base Volume, Demonstration, etc. CONTROLLERS: Flow, Liquid Level, Pressure, Rate and Volume, Remote Control. GAGES: Differential, Volume and Pressure. REGULATORS: Automatic Gas Cut-Off, Back Pressure, Balanced Valve, Bottled Gas, Gas and Air Pressure, High Pressure, etc. LABORATORY GAS TESTING APPARATUS: Calorimeters, Sulphur and Ammonia Test apparatus, Hydrogen Sulphide Test equipment, 1-10 Cubic Foot Bottles, Wet Test Meters, Dry Governors, Wet Governors, Specific Gravity Apparatus, Recording Gravitometers, etc.

ORIFICE METERS

Indicating—Recording—Integrating



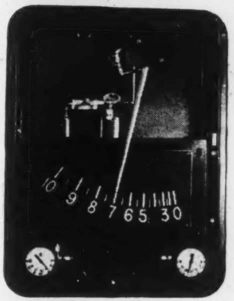
Thousands of American Meter Company's Orifice Meters based on the famous Westcott Manometer are making year-in-year-out records of sustained accuracy in the petroleum producing and refining fields. Complete engineering installation data is included in current bulletins on Recording and Integrating Orifice Meters.



THE DOUBLE INTEGRATING ORIFICE METER gives a totalized reading of the quantity which has passed through the orifice for all flow rates and all pressure variations. It integrates for static pressure as well as for differential.

THE SINGLE INTEGRATING ORIFICE METER charts a totalized reading of the quantity of gas or steam at constant pressure—or for liquids, regardless of the rate.

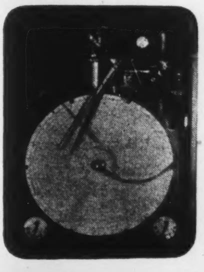
SERIES A-88 PNEUMATIC TRANSMITTER AND CONTROLLER



Many maintenance and servicing problems are answered by the Series A-88 pneumatic Transmitter and Controller operating on standard 3-15 psi air pressure range.

In addition to a high degree of interchangeability of parts and sub-assemblies, the following important features are included:

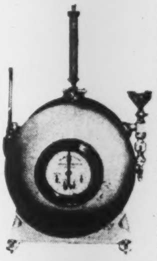
1. NO NEED TO BREAK TUBING CONNECTION for nozzle adjustment.
2. INSTRUMENT CAN BE REVERSED by shifting one link without disturbing other adjustments.
3. LINKAGE ALIGNMENT MADE EASY IN FIELD with positioning device.
4. MAXIMUM PROPORTIONAL BAND CHANGES with minimum output pressure changes.
5. EASY POSITIONING OF NOZZLE permits widening of proportional band without disconnecting tubing, or disturbing other adjustments.
6. DAMPENING DEVICE IN RELAY insures smooth operation.
7. EASY POSITIONING OF LINKAGE MECHANISM by means of housed proportioning bellows incorporating knurled wheel (with locking device).
8. LINEAR ADJUSTMENT between transmitter and receiver.



DRY TEST METERS

The operating mechanism of dry test meters is actuated by diaphragms. The meters are used to measure gas unsaturated with water vapor and are designed to meet the requirements of industries using such diversified gases as air, natural and manufactured gas, butane, propane, high gasoline content gases, hydrogen, oxygen, and acetylene, either dry or moist.

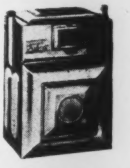
WET TEST METERS

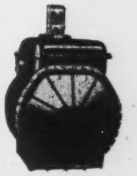


In laboratory testing of gases every detail of American wet test meters from gage glass to water line marker and chromium plated pointer insures not only more precise reading . . . quickly . . . but insures continued accuracy of operation for many years.

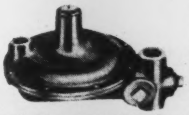
DISPLACEMENT METERS

The complete Ironcase line ranges from the small, low-pressure 5-B type to high pressure meters of maximum capacity.





RELIANCE GAS REGULATORS

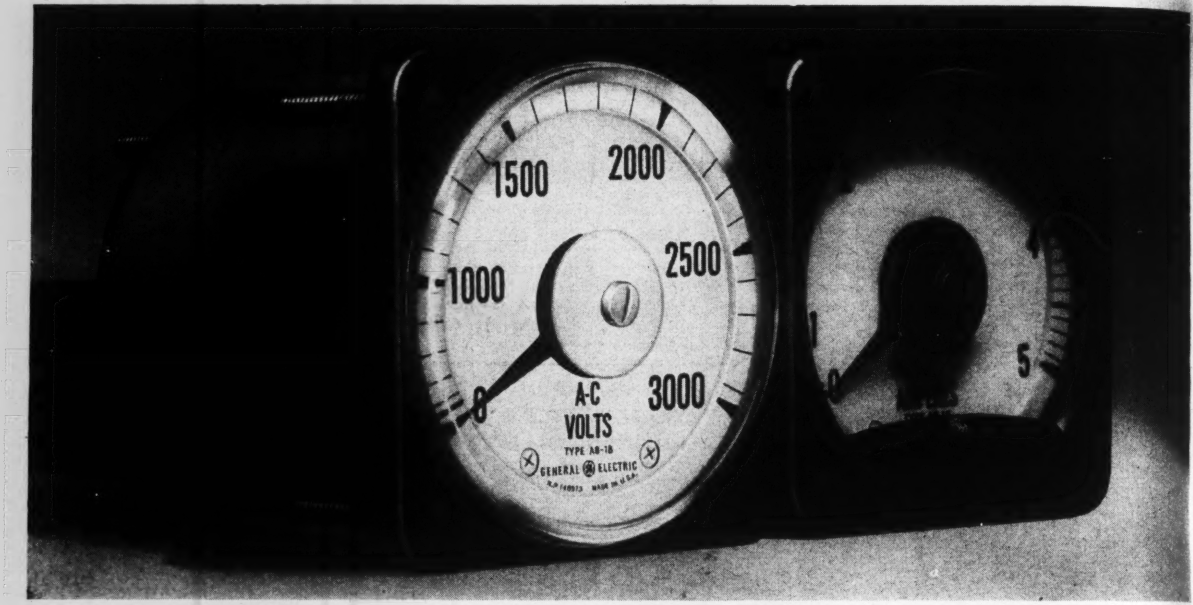


A complete line of high and low pressure types and wide range of models. Close control. Minimum pressure loss, ease of servicing and low cost of upkeep.

GENERAL SALES OFFICE 1513 Race St., Philadelphia
Albany • Alhambra • Amarillo • Atlanta • Baltimore
Birmingham • Boston • Chicago • Dallas • Denver • Erie
Houston • Kansas City • Los Angeles • New York • Odessa
Pittsburgh • San Francisco • Tulsa • Hamilton, Ontario

AMERICAN METER COMPANY

INCORPORATED ESTABLISHED 1836



Both instruments are lighted from above. Note how much easier you can read the new dial

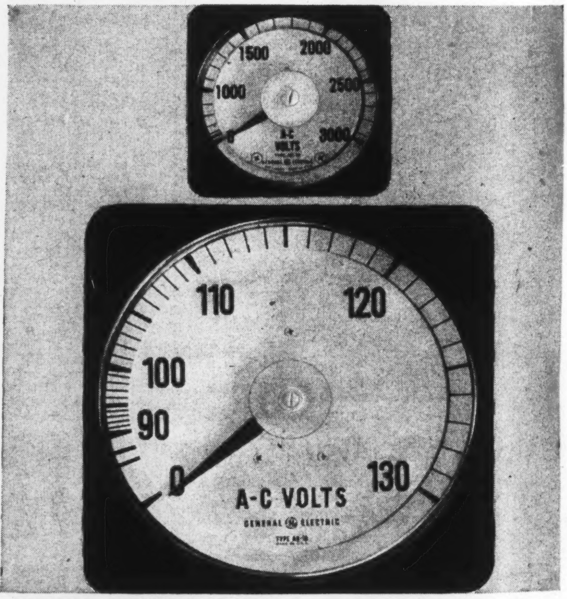
COMPARE THE READABILITY!

Shadow-proof dial makes new G-E instrument easier to read

Two new lines of switchboard instruments—4¼- and 8¾-inch sizes—have just been introduced by General Electric. Here are new instruments you can *read*—always. No more shadows caused by overhead lighting. No more cover overhang. The dial is set forward, flush with the front of the case, and a protruding convex-type glass front provides clear illumination from any angle. Anti-glare glass prevents reflections. Even when the lighting angle is sharp, you can easily read these instruments.

You can obtain shadow-proof instruments in both sizes as ammeters, voltmeters and wattmeters; frequency and power-factor meters; temperature indicators and synchroscopes.

Specify General Electric shadow-proof instruments for control stations, testing devices and other installations. Ask your G-E representative today for more information or write for bulletin GEC-218B, General Electric Co., Schenectady 5, N. Y.



AVAILABLE IN TWO SIZES. **Type AB, DB-18 is 4¼ in. square, 250-degree scale, 7.1 inches long. Type AB, DB-16 is 8¾ inches square, 250-degree scale, 14.2 inches long. Both have 1% accuracy.**

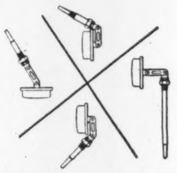
GENERAL ELECTRIC

602-191C

PALMER THERMOMETERS are accurate—very accurate

PALMER Dial THERMOMETER

Adaptable and interchangeable with all Industrial Thermometer applications. MERCURY-ACTUATED. Guaranteed accuracy. Size: 4½" Dial.



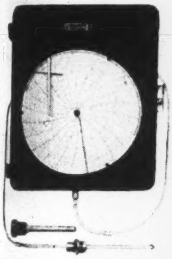
Designed for use as STRAIGHT or any ANGLE. With clear vision all-glass moulded case and metal back. Fittings: Plain, Union, Socket; adjustable or union Flanges.

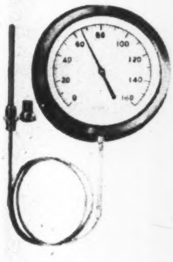
STANDARD RANGES:

		+200+900°F.5°
—40+100°F.1°	0+400°F.5°	0+110°C.1°
0+150°F.1°	0+500°F.5°	0+150°C.1°
0+240°F.2°	0+600°F.5°	0+240°C.2°
0+300°F.2°	+200+750°F.5°	0+300°C.2°

(Write for NEW Bulletin No. 128)

RECORDING and DIAL THERMOMETERS





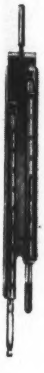
With Flexible Tubing Connection.

Mercury-actuated, for extreme accuracy. Sturdy construction, very sensitive. All parts rust-proof. Stainless-steel bulb. Wall or Flush Mounting. Bottom or Back connection. Fittings: Plain, Union, Sep. socket; Adj. or Union Flanges. Ranges: —40 to 1000° F. (or C).

RECORDER: 12" die-cast alum. case; Black or white, satin or wrinkle finish; elec. or spring clock; 12 hr., 24 hr., or 7-day charts. One-pen or multiple pens. Also Fully compensated to correct for Ambient Temperature.

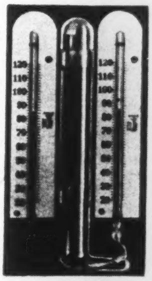
DIAL: 6" and 8" round case. Black or white finish. Easy-reading dial.

(Write for 1951 edition #200-G Catalog)



PSYCHROMETER and HYGROMETERS

For testing humidity. Chart furnished. Wet and Dry bulb with "Red-Reading-Mercury" lens tube for easy reading. Sling Psychrometer — in metal case. Wall Hygrometer—with water reservoir. +30+110°F. +80+220°F.



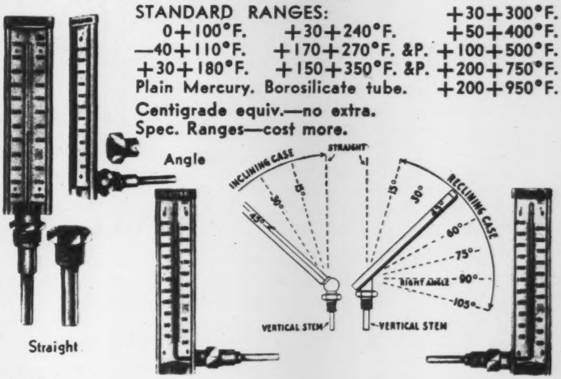
INDUSTRIAL THERMOMETERS with "Red-Reading-Mercury"

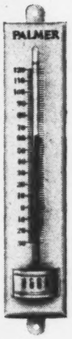
CASE: 7", 9" or 12" Extruded brass. Wide scale. Chrome finish.
TUBE: Red Reading Mercury Easy to Read. Thoroughly annealed for permanent accuracy. Protected by double-strength glass shield. Graduated scale.
FITTINGS: Fixed thrd., Union, Sep. Socket; adjustable or union Flange; parallel thrd. & locknut; special fttgs. to order.
STEM: STRAIGHT and Misc. ANGLES. 3½" to 60", incl. thread.
THREAD: ¾" or 1" NPT. (½" not recom.)

STANDARD RANGES:

		+30+300°F.
0+100°F.	+30+240°F.	+50+400°F.
—40+110°F.	+170+270°F. &P.	+100+500°F.
+30+180°F.	+150+350°F. &P.	+200+750°F.
Plain Mercury. Borosilicate tube.		+200+950°F.

Centigrade equiv.—no extra.
Spec. Ranges—cost more.



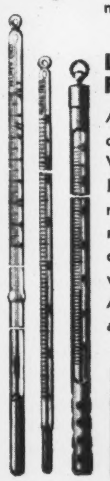


SMALL CASE THERMOMETERS

4" case: ⅜" & ½" Fixed Thrd. Fttg.
6" case: ½" & ¾" Sep. Socket Fttg.
Extruded case. Durable Nickel finish.
"Read-Reading-Mercury". Guaranteed accurate.

WALL THERMOMETERS

Indoor or outdoor. Very accurate. 12" copper case, with removable Tube and scale. 10" metal scale, with hangers top & bottom. All with lens mercury tube, showing wide RED column.



LABORATORY AND PRECISION THERMOMETERS

All glass engraved mercury tube, with vivid RED column. Round or lens; Ring or button top; With or without metal armor; Total or partial Immersion (3" standard). Each in sep. box. All ranges: up to 750° F. (or C. equiv). Plain mercury. Borosilicate tube. +200+950°F. Special ranges & dimensions to order. Fractional division, A.S.T.M. etc.

Also handy 5" Pocket style. Annealed and guaranteed very accurate.

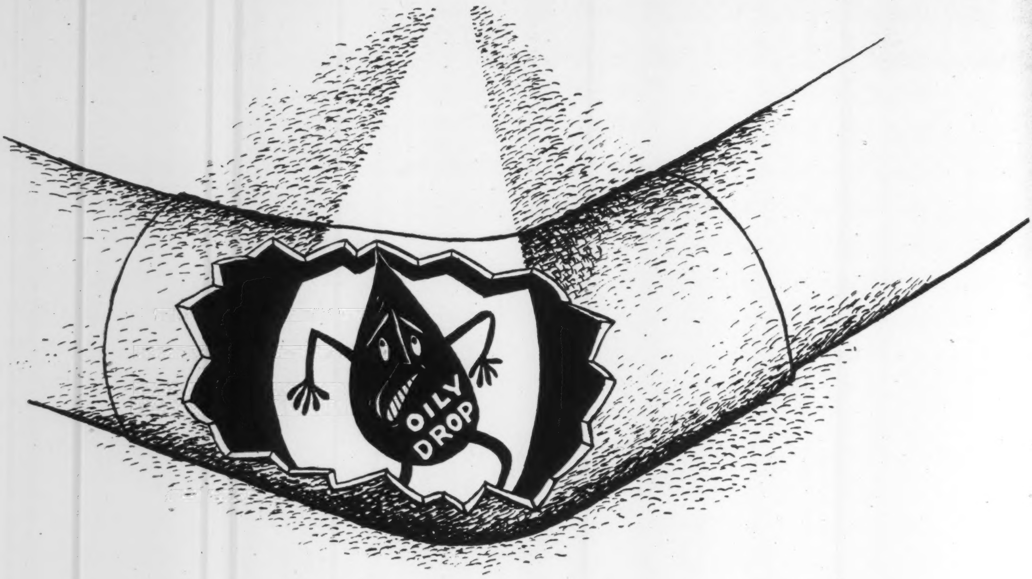
REPAIRS—To all makes of mercury Industrial Thermometers. With "Red-Reading-Mercury" (no extra cost) and new Extruded Brass case included. Guaranteed accurate. Reasonable price.

• PALMER THERMOMETERS, INC. •

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2518 NORWOOD AVE., CINCINNATI 12, O.

CANADIAN PLANT: PALMER THERMOMETER LTD., TORONTO, 2



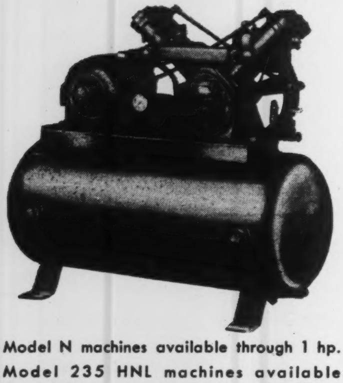
spotlighting a different kind of saboteur in vital instrument lines!

Oil-laden air can knock out your air-operated instruments . . . just as effectively as a "fifth columnist" can! When a slug of oil hits, you know what it can mean in production losses and excessive maintenance. That's why you'll be interested in this news about an easy, economical way to eliminate oil in instrument lines:

Ingersoll-Rand has engineered special air compressors that deliver *oil-free* air. These I-R Compressors feature pistons fitted with patented, graphitic carbon rings. The rings prevent metallic contact of the piston with the cylinder bore. The carbon rings are segmental with metallic inner expanding rings to give the proper wall pressure. Because metallic contact is eliminated, and the rings are self-lubricating, the Ingersoll-Rand NL Compressor cylinders require no lubricant.

If oil-laden air has *ever* caused you trouble, Ingersoll-Rand has engineering facts and figures that will interest you. Just contact your nearest I-R representative, or write direct to Ingersoll-Rand, 11 Broadway, New York 4, New York.

676-1



Model N machines available through 1 hp.
Model 235 HNL machines available through 3 hp—other models through 250 hp.

Ingersoll-Rand

NL COMPRESSORS

. . . 70 years of compressor "know-how" packed into these new compressors for air operated instruments!

Quick Check List

OF INSTRUMENTS BY FOXBORO

Reg. U. S. Pat. Off.

INDICATORS • RECORDERS • CONTROLLERS

Air Weight

***Conductivity**

***Consistency**

Density (Specific Gravity)
differential pressure type

Flow
mercury-manometer type
"d/p Cell", force-balance transmitter type
float-and-cable type

Humidity
wet-and-dry-bulb temperature
relative humidity (hygroscopic type)
absolute humidity and dew point temperature ("Dewcel")

Liquid Level or Interface (in open or pressured vessels)
diaphragm type
bubble tube (purge) type
differential pressure type

***Load, Force, and Torque**

***Moisture Content (sheeted materials)**

Motion and Position Recorders

***Motor Load (Power)**

Operation Time Recorders

***pH (with Beckman glass electrodes)**

Pressure, Absolute Pressure, and Vacuum
spring and hydron types
differential type
*electric pressure cell types

***Resistance (Electric)**

***Speed (R.P.M. or Lineal)**

Temperature
filled-system types
resistance bulb ("Dynalog" electronic and galvanometer types)
thermocouple ("Dynalog" electronic and galvanometer types)

***Tension**

***Thickness (sheeted materials)**

***Viscosity**

***Voltage, Current, Impedance, Dielectric**

***Weight (sheeted materials in process)**

***Weight and Force (strain gauge type)**

CONTROLLER TYPES

Pneumatic

Model 40: On-Off
- Proportional
- Proportional with Derivative
- Proportional with Reset ("Stabilog")
- Proportional with Reset and Derivative ("Hyper-Reset")

Consotrol (Console/Graphic Panel Types): in all above control mechanisms except on-off
Model 41: On-Off and Proportional
Round Case: On-Off and Proportional

Electric

Rotax (rotary contact type)
- On-Off
- Multi-Position

Galvanometer Type
- On-Off
- 2- and 3-position
- Proportioning

CONTROL SYSTEMS

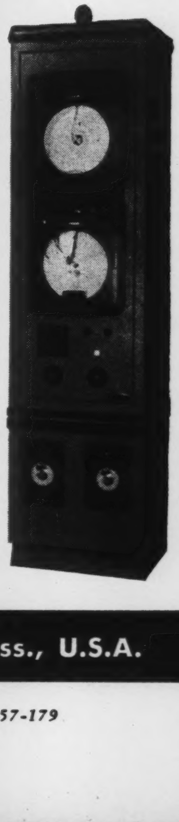
Auto-Selector
Averaging
Dual
Duplex
Limit
Ratio
Relation
Sequence
Time Schedule
(cam and camless types)

*with Dynalog Electronic Instruments

COMPLETE AUTOMATIC CONTROL UNITS

Any combination of Foxboro instruments required for precise control of an industrial process now is available in a complete pre-engineered cabinet assembly. Foxboro Automatic Control Units come fully assembled. All instrumentation is expertly connected and coordinated at the factory. Installation of complete control system requires only simple external connections of air and power supply, and primary measuring elements.

Shown at the right is a typical Foxboro Cabinet type Integrated Process Control System. Other combinations of standard units incorporate any required number of recording and controlling instruments plus gauges and other supplementary equipment.

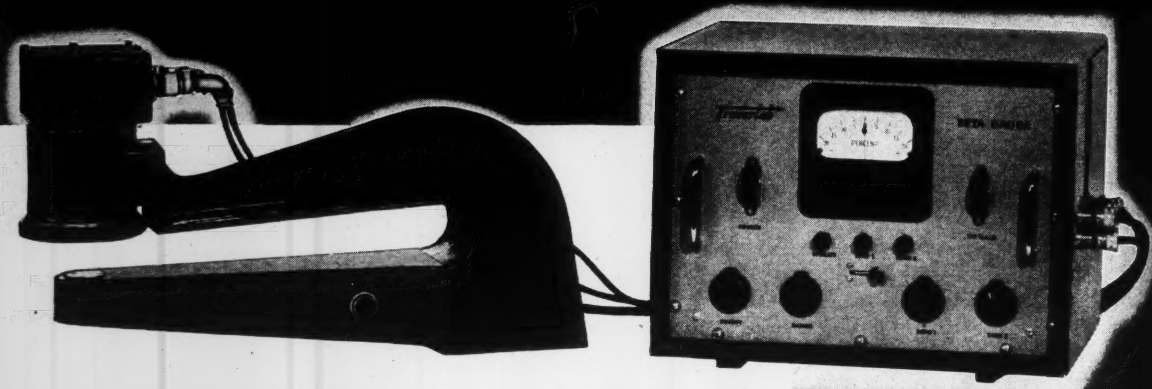


THE FOXBORO COMPANY, 4613 Neponset Ave., Foxboro, Mass., U.S.A.

THICKNESS CONTROL A PROBLEM?

Tracerlab Beta Gauges

CUT COSTS—IMPROVE QUALITY



TRACERLAB's new model, non-contacting Beta Gauge measures and records the weight per unit area or thickness of sheet materials. Because beta radiation is used, a high degree of accuracy and sensitivity is achieved, unaffected by variations in chemical composition of the material being gauged.

Tracerlab developed the first Beta Gauges, and the experience gained through having these instruments in successful, everyday operation in a number of diversified process industries has now been incorporated in a new and outstanding gauge. Featured are simplicity of operation, ruggedness of design and reliability of operation — all combined in an instrument that maintains Tracerlab's established leadership.

The gauge's low cost will be rapidly repaid from raw material savings resulting from closer manufacturing tolerances and faster control, plus a greater uniformity of product with its resulting advantages. A meter showing percentage variation from normal, or a meter calibrated directly in weight or thickness, is standard equipment. Where a continuous record is desired, various types of recorders are available.

For non-contacting gauging of materials accessible only from one side, Tracerlab manufactures a model which operates by measuring "back scattered" beta particles. This gauge is particularly useful in gauging rubber, paper, plastics and other materials as they pass over a calender roll. It has also proved highly effective in measuring thickness of coatings on certain substances.

For complete information, write for Bulletin BG-RI.

Tracerlab
BETA GAUGES
are NOW gauging:

CARDBOARD
•
PLASTICS
•
PAPER
•
ADHESIVE TAPE
•
SHEET METAL
•
RUBBER
•
PAPER COATINGS
•
METAL FOIL
•
PLASTIC COATINGS
•
PHOTOGRAPHIC COATINGS
•
LINOLEUM

SALES OFFICES:
BERKELEY, CAL., CHICAGO, ILL.
NEW YORK, N. Y.
WASHINGTON, D. C.

Tracerlab

TRACERLAB INC., 130 HIGH STREET, BOSTON 10, MASS.

INSTRUMENT PANELBOARDS by FALSTROM

Falstrom-Built Means Built by Experts! FALSTROM engineers in the field continually exchange ideas with leading instrument men to see what new designs or construction features FALSTROM can recommend which will make a more efficient and economical panel for mechanical or electrical equipment. Many of their meetings have resulted in the introduction of standards now accepted 'round the world — wherever instrument boards serve.

What Does Your Problem Deal With? Housing, casings, enclosures, switchboards, gageboards, turbine or boilerboards, mechanical or electrical panels, complete control centers, benchboards, pumpboards, meterboards, double-faced cubicles, outdoor type cubicles—? Send us your blueprints for quotations and ask about our standard designs.

Metal Fabricating Division In addition to its Panelboard Division, FALSTROM has excellent facilities for custom metal fabrication. For contract manufacturing at practical unit costs, send your blueprints for pricing to FALSTROM COMPANY, Metal Fabricating Division, 90 Falstrom Court, Passaic, N. J.

Send for Literature Your request will get these informative, illustrated bulletins; Modern Design for Instrument Panels and Cubicles, Instrument Panelboards by FALSTROM, Steel Products for all Purposes, or Equipment Appearance — Re-Design. See our monthly advertisements next to Table of Contents in "Instruments".

STANDARD PANELS BY FALSTROM

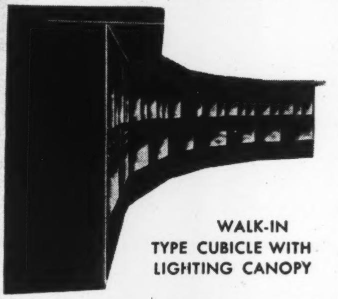
The economical solution to many steel panel requirements. They are designed in several sizes and thicknesses and are equipped with standard accessories. Falstrom Standard Steel Panels are designed for use singly or in groups to accommodate practically all types of installation. These panels are not stock items — but standard dies speed delivery.

FALSTROM CONSOLE CABINETS

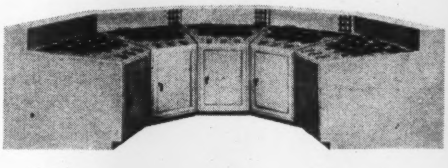
The designing, engineering and fabricating divisions of FALSTROM are equipped to produce any size or style of instrument board to specification. Features such as lighting canopies, graphic panels, access doors, color finishes, air filters, blowers or exhausters and other special equipment can be built-in during production.

FALSTROM-BUILT CUBICLES

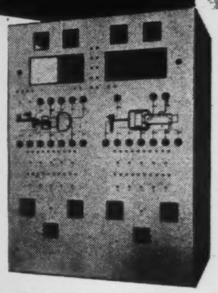
The fully enclosed self-supporting instrument or control housing has several very important advantages. Added protection is provided against damage, dust and tampering. This type structure is now in wide use in industry. Falstrom engineers welcome the challenge to meet your specific applications.



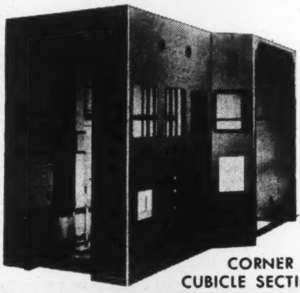
WALK-IN TYPE CUBICLE WITH LIGHTING CANOPY



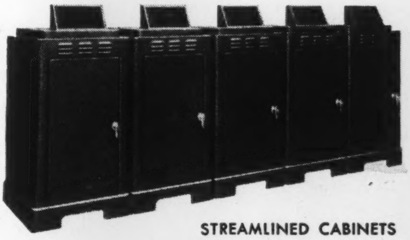
BENCHBOARD CONSOLE



GRAPHIC SELF- SUPPORTING PANEL



CORNER CUBICLE SECTION



STREAMLINED CABINETS

MONITOR DESK CONTROL BOARD

FABRICATORS OF METAL
PRODUCTS FOR INDUSTRY
SINCE 1870

—for all *PANELBOARD* requirements specify—

FALSTROM COMPANY

90 FALSTROM COURT, PASSAIC, NEW JERSEY

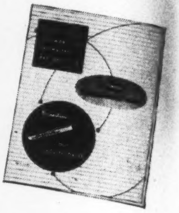
Fenwal

THERMOSWITCH®

Precision, Multi-Purpose Thermostat Controls

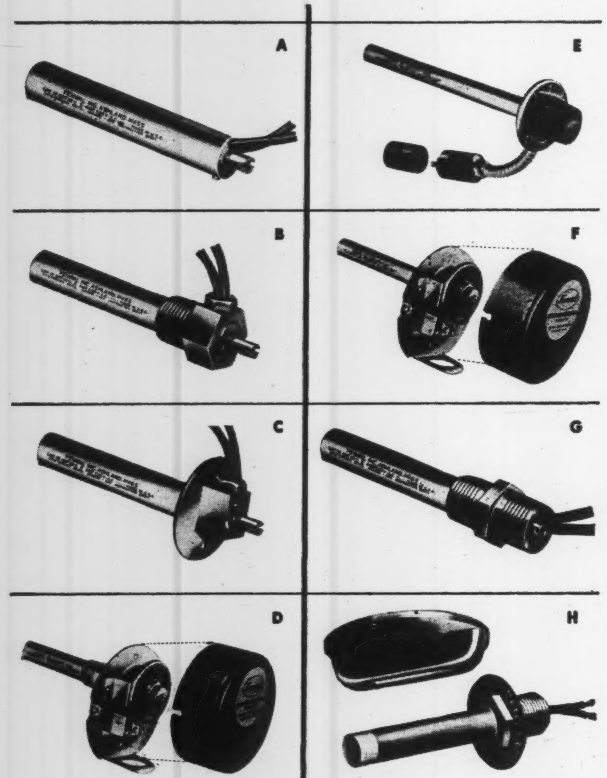
SENSITIVE . . . *but only to heat*

In a THERMOSWITCH thermostat the activating element is the *single-metal* temperature-sensitive shell which, in direct contact with the ambient temperature to be controlled, expands *without lag*, causing the contacts inside to open. Completely enclosed against dust. Shock and vibration proof, the THERMOSWITCH control also provides high load-carrying capacity, wide adjustment range and ease of installation. No other thermostat on the market today offers you so many assurances of positive, accurate temperature control, long service life and operating economy.



SEND FOR FREE BOOKLET containing further details on unique THERMOSWITCH thermostat. Write Fenwal, Incorporated, 170 Pleasant St., Ashland, Mass., 111 South Burlington Ave., Los Angeles 4, Cal.

Which of these THERMOSWITCH types fits your requirements?



CARTRIDGE TYPE

A. This compact, small-sized, self-contained unit is the basis for mos THERMOSWITCH models. For temperatures ranging from —100F to +400F (or +100F to +600F). Higher ranges also furnished.

HEX HEAD

B. Furnished with ½″ (or ¾″) standard pipe thread for mounting i tapped hole or suitable boss.

FLANGE HEAD

C. Has flange 1¾″ in diameter with three tapped holes for mounting on any flat surface.

JUNCTION BOX — IMMERSION

D. Has conduit junction box attached. Threaded hexagon section permi immersion of brass shell in fluid through tapped hole or boss. Cove houses terminal block, dial and knob. Special units available wi Underwriters' Listing.

ALL-PURPOSE

E. Comes with extended nickel-plated shell, dial, knob and midget pl connector for experimental or general laboratory work.

JUNCTION BOX — AIR

F. Has an electric conduit junction box attached to the extended shell of a basic cartridge unit. For air ducts, ovens, driers, etc.

COUPLING HEAD

G. Has ½″ or ¾″ standard male pipe threads at each end of its hexago mounting section. Simplifies attaching to conduits and explosion-proo fittings.

DETECT-A-FIRE

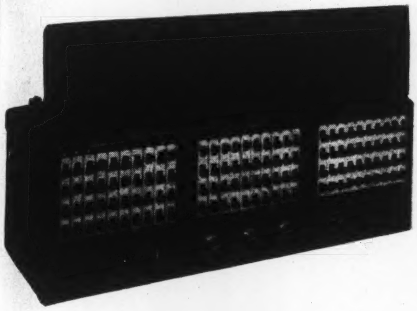
H. Unique new Rate-Compensation principle of fire detection does away with time lag, false alarms. Unit responds only when temperature of surrounding air reaches predetermined danger level. (1) Horizontal model Series 70 for commercial, industrial and public buildings, institutions and ships in locations electrically classified as "ordinary." (2) Explosion-proof vertical model Series 71 listed and approved for locations electrically classified as "hazardous" . . . i.e., Class I, Groups C and D; Class II, Groups E, F, and G . . . as well as "ordinary" locations. Both models listed by (UL). Approved by ⟨FM⟩.

FENWAL INCORPORATED Ashland, Massachusetts

DO IT WITH PUSHBUTTONS!

WHY USE "HORSE AND BUGGY CONTROLS" — "IN A JET AGE?"

CASE TYPE



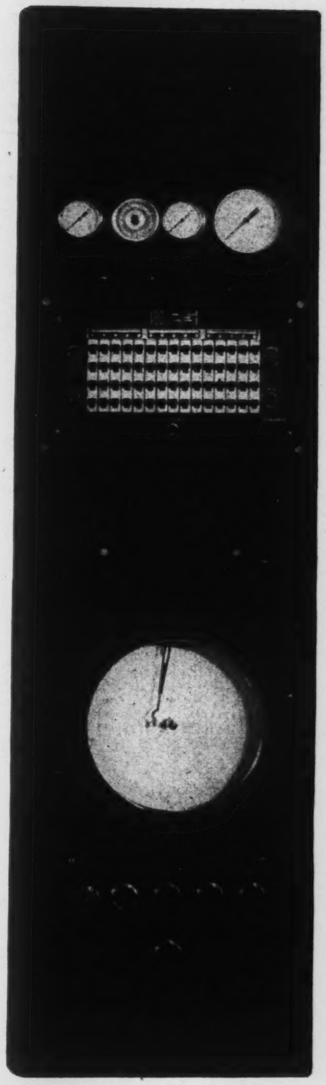
SET UP IN SECONDS
NO CAMS! NO GEARS
NO DRY RUNS
NO ADJUSTMENTS

Graphic type pushbutton panels permit instant cycle changing by the mere flick of a button! No longer is automatic control impractical due to short runs and varied cycle requirements.

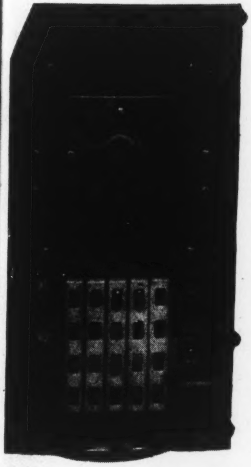
Complex sequences are no longer difficult to obtain. The ROBOTRON pushbutton cycle controller has been designed to make set-ups easy for even non-technical supervision. Fully electrical, without electronic tubes or delicate components, the ROBOTRON design has been reduced to only one moving part other than the motor, and wear has been eliminated as a control problem. As there are no adjustments, another major maintenance problem, that of keeping equipment adjusted, has been removed.

ROBOTRON CONTROLS, tuned to this Jet Age, spearhead the present drive against waste, inefficiency, and lost production. They lead in raising standards of quality and increasing productivity of present equipment.

PANEL TYPE



CABINET TYPE



- **SIMPLICITY**
- **DEPENDABILITY**
- **EASE OF SET-UP**
- **FLEXIBILITY**
- **TROUBLE-FREE SERVICE**

Available in many models, from the simple to the very complex, ROBOTRONS also are custom-designed in various case types. Panel mount types adapt to modern installations and are suitable for including as original equipment on hydraulic presses or other machinery. Case types are suitable for average requirements, and the cabinet types permit grouping in control centers away from the dirt and abuse of the press room. Long, dependable, wear free and positive control will prove the economy and value of ROBOTRONS.

Additional data can be sent upon receipt of a statement of your control sequence.

Catalog showing Complete line upon request.

OTHER *Products of* **MERIT** INCLUDE

3000 LB. - 5000 LB. HYDRAULIC DIAPHRAGM VALVES - 300 LB. - 500 LB. DIAPHRAGM VALVES
TEMPERATURE CONTROLLERS - PRESSURE CONTROLLERS - CERAMIC VALVES

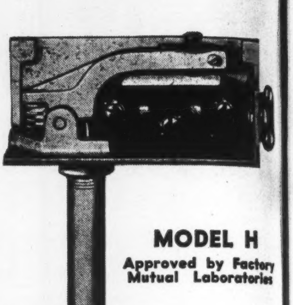
EMMETT MACHINE & MANUFACTURING, INC.

2249 FOURTEENTH ST., S. W.   AKRON 14, OHIO   PHONE SH-3101

BURLING TEMPERATURE CONTROLS

Improved High Temperature Safety Switch. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell—with single pole double throw switch . . . breaks heating circuit while closing alarm circuit.

• Accurate, Rugged, Dependable. • Corrosion and heat resisting tube. • Dial Pointer for easy setting inside case. • Locking screw locks temperature setting. • Terminal plate has large screw terminals. • Snap-action Micro-Switch eliminates contact troubles. • Range minus 100° to 1400°F. Adjustable range 200. • Dimensions —5⅛" x 1¾" x 3".

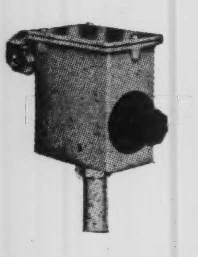


MODEL H

Approved by Factory Mutual Laboratories

MODEL "Y"

Temperature Controlled Valve



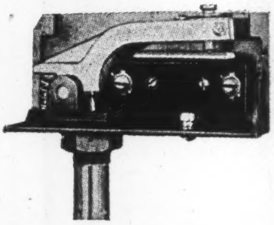
For controlling temperature of equipment by controlling flow of fuel, controlling temperature of equipment by controlling flow of cooling medium, high or low temperature safety cut off, high or low temperature safety cut off for air operated valves.

Temperature range from minus 300° F. to plus 1800° F. Readily interchangeable bronze spring-closing valve with removable discs for air, water, gas, oil, steam, or gasoline. Sizes ¼", ⅜", ½", and ¾". No back lash or lost motion in movement of valve. Available with temperature setting inside (Model Y) with temperature setting outside (Model YD) Available for closing valve on rise in temp. (Models Y & YD) for opening valve on rise in temp. (Models YR & YRD)

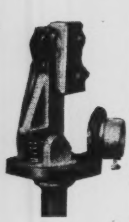
MODEL H

With Manual Reset Button

Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell—with single pole double throw switch that breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside case. Range 0-1400° F; adjustable range 200-250° F. Dimensions: 5½" x 1¾" x 3". Dial pointer for easy setting.



MODEL V-1

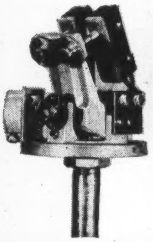


Designed for the lower temperature range from 0-300° F. Model V-1 is also available for minimum of —100° to maximum 600° F. Usual adjustable range is 50-150° and operating differential may be as small as ±¼° or as large as ±5°. Adjusting screw and dial are inside of case. Dimensions: 2¾" dia. x 4¼" high.

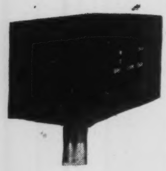
EXPLOSION PROOF HOUSINGS—Models V-1 and VD-2 can be mounted in explosion proof housings. When so mounted V-1 can be furnished for any temperatures from minus 100° to 1400° or 1600°. Model VD-2 can be furnished with the temperature adjustment either inside or outside the case.

MODEL VD-2

Contains 2 snap-action Micro-Switches which may be any two of the following types: Normally open, normally closed, single pole double throw switch. The switches are mounted on a moving lever and both switch lever and adjusting lever rotate about a common axis. Each switch has an individual adjusting screw and locking disc, thus making it possible to adjust the differential between switches from very close limits to a maximum of 150-200° F. The main temperature can be changed without changing differential between switches. Main adjusting screw is usually outside but may be had inside upon request. Suitable for temperatures up to 1200° F. Adjustable range 300-600° F. Size 3½" dia. x 4⅝" high.



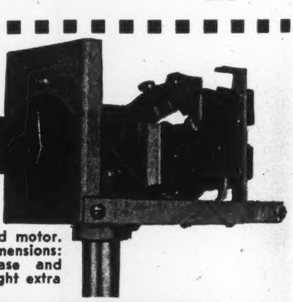
MODEL D



Same general characteristics as Model H but for use where temperatures must be changed to suit oprating conditions. Turn outside knob to change temperature setting. Simple in design . . . accurate and dependable under severest operating conditions. Temperature range 0-1400° F. Standard adjustable range 200°-500° F. Dimensions 5½" x 2¾" x 2¾".

MODEL E

only 1 light-weight moving part. Available with 1, 2 or 3 switches.



As a 3 switch model, Burling Model E is recommended for use (a) where load is divided into 3 parts (b) where 1 switch is used for controlling, one as a high limit, one as a low limit, (c) to give definite stops or position to a 3 or 4 position diaphragm motor, (d) to give 3 speed control of variable speed motor. Adjustable range to 700-1000°. Dimensions: 7¼"x2¾"x3½". Vapor tight base and cover with gasket available at slight extra charge.

Over 12 years specialization in the design and manufacture of precision temperature controls stand behind every Burling Instrument. This broad experience makes it possible for Burling to solve even the most specialized problems in this field.

The Burling engineering department is ready to work with your engineers on all types of temperature control problems. Our broad experience with situations involving high pressures, corrosion, average temperature across a duct, explosion-proof housings, etc. is at your disposal. Among the many satisfied Burling customers are such nationally known concerns as:

Aluminum Company of America
Aluminum Company of Canada
American Type Founders, Inc.
Anaconda Wire & Cable Co.
Jabez Burns & Sons
Detroit Aluminum & Brass Corporation
E. I. du Pont de Nemours & Company, Inc.
Eagle Pitcher Lead Company
Eastman Kodak Company
Walter Kidde Company
Lydon Brothers
Morrison Engineering Company
J. O. Ross Engineering Corporation
Standard Oil Company of New Jersey
Sta-Warm Electric Company
Swindell-Dressler Corporation
Harold E. Trent Company

Illustrated literature on request

BURLING INSTRUMENT COMPANY

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The GOTHAM CONVERTIBLE

a recorder you never outgrow!

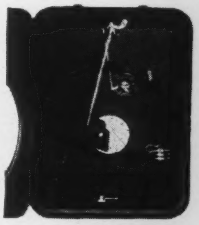
The most convertible, most interchangeable, most maintenance-saving instrument you've ever seen.

Deliberately designed so that the basic elements are identical for the 6", 9" and 12" chart size recorders. Temperature and pressure systems are also completely interchangeable. This flexibility enables you to convert instruments to suit your changing needs, at a minimum cost, minimum inventory, and without delay at the job site. Control through air relay or solenoid easily added. Full details in Catalogs 400 and 500.

What you can do with the Gotham Convertible

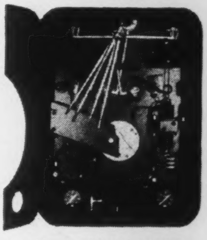
	Chart Size		
Function	6"	9"	12"
1-Pen Recorder	X	X	X
Single Temperature or Pressure Controller, Indicating	X	X	X
2-Pen Recorder*		X	X
3-Pen Recorder*			X
4-Pen Recorder*			X
1-Pen Recorder-Controller		X	X
2-Pen Recorder-Controller*			X
1-Pen Recorder-Controller and 1-Pen Recorder *			X
1-Pen Recorder-Controller and 2-Pen Recorder *			X

Functions above may be either Temperature or Pressure or Mixed (*)

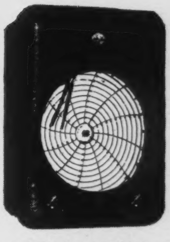


IT'S A TEMPERATURE RECORDER

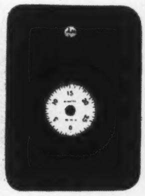
IT'S A PRESSURE RECORDER



IT'S A TEMPERATURE OR PRESSURE RECORDER AND CONTROLLER

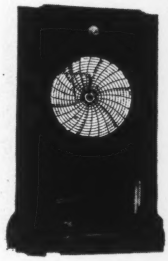


EXTERIOR OF THE GOTHAM CONVERTIBLE



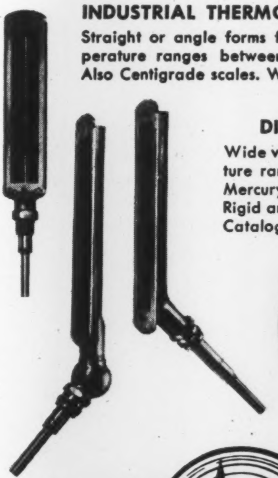
AUTOMATIC TIMING CONTROLLER

Multiple cam type, designed to start and control a sequence of process operations. Opens or closes air valves or electric switches. Available in single cam type. Write for Catalog 500.



RECORDING PSYCHROMETER

Wet and dry bulb. Motor driven suction-type blower. Standard chart drive. Similar design available for Recording and Recording-Controlling Hygrometers. Write for Catalog 400.

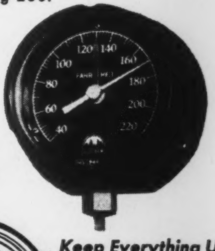


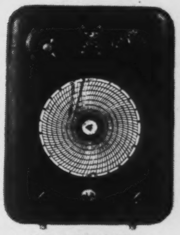
INDUSTRIAL THERMOMETERS

Straight or angle forms for all purposes. Temperature ranges between —40°F. and 950°F. Also Centigrade scales. Write for Catalog 100.

DIAL THERMOMETERS

Wide variety of case styles, temperature ranges, connections and fittings. Mercury, vapor, or gas-actuated. Rigid and adjustable stems. Write for Catalog 200.





PROGRAM CONTROLLER

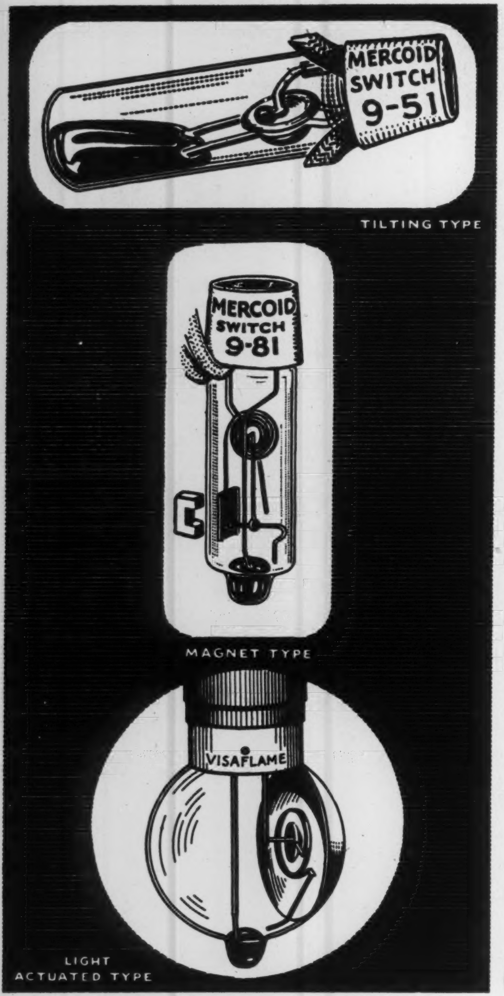
Controls either temperature or pressure vs. time. Controls and records time, rate of rise, hold value, and rate of cooling. All adjustments in this new instrument made from outside of case. Write for Catalog 500.

PORTABLE RECORDERS—Handy, light-weight, mercury or vapor actuation, 6", 9", 12" chart sizes. See Catalog 400.

Keep Everything Under Control With Gotham

GOTHAM INSTRUMENTS

Division of AMERICAN MACHINE AND METALS, INC.
Sellersville, Pennsylvania



MERCOID MERCURY SWITCHES

HERMETICALLY SEALED

There are three primary operating types of Mercoid mercury switches as illustrated.

Tilting Type, of which there are a variety of sizes, electrical capacities and circuit arrangements.

Light Actuated Stationary Type—circuit in this mercury switch closes in the presence of light of a flame and opens when the light is absent.

Magnetic Type, applied in a stationary position. The circuit is opened or closed by means of a permanent magnet; however, a small milli-ampere electromagnet may be employed.

There are many outstanding advantages of Mercoid mercury switches. They are immune to dust, dirt or corrosion and will operate indefinitely without deterioration.

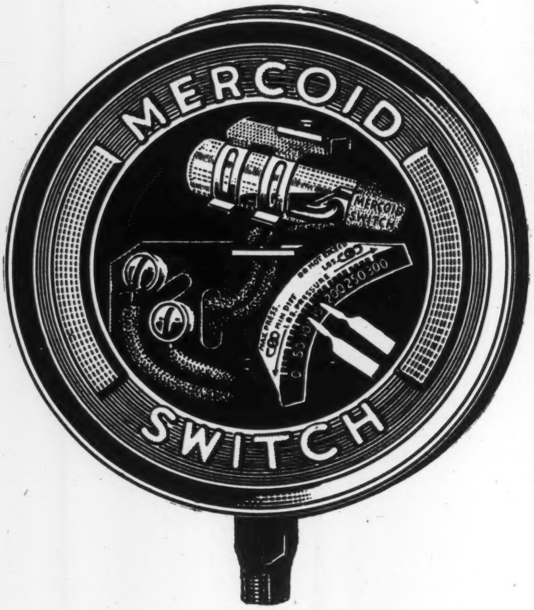
They are all adaptable for numerous applications where open contacts are not suitable.

OUR ENGINEERING DEPARTMENT WILL ASSIST YOU ON ANY OF YOUR SWITCH PROBLEMS

MERCOID

AUTOMATIC CONTROLS

The Choice of Experienced Engineers



CONTROLS

FOR INDUSTRIAL APPLICATIONS REQUIRING POSITIVE CONTROL OF PRESSURE, TEMPERATURE, LIQUID LEVEL ETC.

SIMPLE TO ADJUST FOR THE
SPECIFIED OPERATING RANGE

MERCOID CONTROLS ARE EQUIPPED WITH MERCURY SWITCHES, THEREBY INSURING GREATER SAFETY, BETTER PERFORMANCE AND LONGER CONTROL LIFE

WRITE FOR CATALOG 700---PLEASE MENTION THIS PUBLICATION

BRANCH OFFICES • 205 East 42nd Street, NEW YORK • 3137 North Broad Street, PHILADELPHIA

THE MERCOID CORPORATION · 4223 BELMONT AVENUE · CHICAGO · 41 · ILLINOIS

Manufacturers of dependable automatic controls for over a quarter of a century

Superior Tube Company produces round and shaped tubing in the following analyses:

(.010″ to ⅝″ O.D. Max. Certain Analyses .035″ max. wall to 1⅜″ O.D.)

Carbon Steels:
A.I.S.I. C-1008, MT-1010, MT-1015, C-1118, MT-1020, C-1025, C-1035, E-1095.

Alloy Steels:
A.I.S.I. 4130, 4132, 4140, 4150, 8630, E-52100.

Stainless Steels:
A.I.S.I. 303, 304, 305, 309, 310, 316, 317, 321, 347, 403, 410, 420, 430, 446, T-5.

Nickel and Nickel Alloys:
Commercial Nickel, "D" Nickel (4½% Mn Nickel), "L" Nickel, "Monel", "K" Monel, "Inconel", "Inconel X", Nichrome "V", 30% Cupro Nickel, 18% Nickel Silver.

Beryllium Copper

• • •

Superior Tube Company is represented in all principal cities of the United States and Canada by selected distributor organizations with warehouse facilities.

UNLIMITED
DESIGN POSSIBILITIES

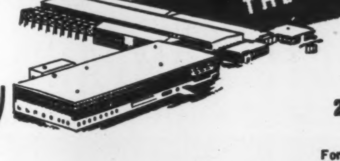
For the instrument maker, Superior furnishes tubing in cut, multiple or random lengths, shaped to "standard" specifications—or your specialized designs. Flat and elliptical ovals for bourdon springs can be produced in any analysis shown in the accompanying table.

Superior Shaped Tubing Specification and Tolerance Sheets list all the shapes and sizes for which tools are prepared and in stock. While the specification sheets are not available for general distribution, a Superior representative will gladly call at your office to review your dimensional, analysis and delivery requirements.

You are invited to make full use of this Superior service—your request will receive prompt attention.

Superior

THE BIG NAME IN SMALL TUBING



ALL ANALYSES .010″ TO ⅝″ O.D.
CERTAIN ANALYSES (.035″ MAX. WALL) UP TO 1⅜″ O.D.

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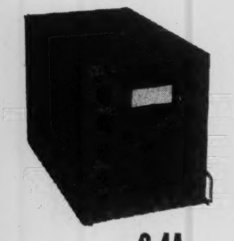
THE WATERMAN LINE-UP

PULSESCOPES

RAKSCOPES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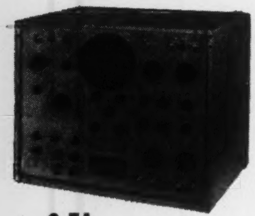
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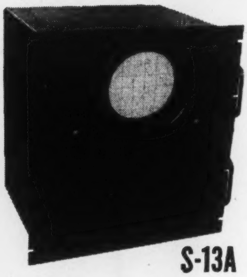
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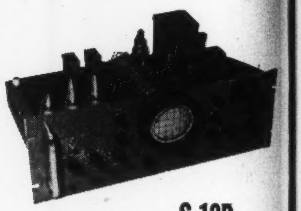
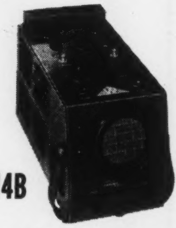

S-12B

POCKETSCOPES

S-11A

S-14A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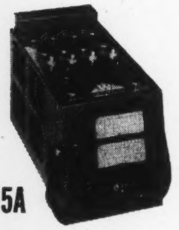
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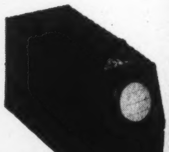
S-10B

CONDENSED TABLE OF SPECIFICATIONS

		S-4A	S-5A	S-10B	S-11A	S-12B	S-13A	S-14A	S-14B	S-15A
CR TUBE	QTY & TYPE	1—3KP1	1—3JP1	1—2AP1	1—3MP1	1—3RP1	1—7GP4	1—3RP1	1—3RP1	2—3SP1
	VOLTAGE	1000	3000	350	560	920	3000	900	900	900
SCOPE	CHANNELS & TYPE	1—AC	1—AC	1—AC	1—AC-DC	1—AC-DC	1—AC-DC	1—AC-DC	1—AC-DC	2—DC
	MARKERS μs	10 and 50	.2 to 500	....	....	....	....	....	....	....
	CALIBRATION	YES	YES	....	....	....	....	YES	YES	YES
VERTICAL RESPONSE	MAX. RMS V/IN	.24	0.04	1.0	.1	0.05	0.05	0.01	0.05	0.01
	SINE CPS —2DB	2—8.5 MC	6—7 MC	20—150 KC	0—200 KC	0—200 KC	0—600 KC	0—180 KC	0—700 KC	0—180 KC
	PULSE RISE μs	0.035	0.045	....	2	1	0.4	1.8	0.35	1.8
HORIZONTAL RESPONSE	MAX. RMS V/IN	....	3	1.0	0.1	0.05	0.05	0.015	0.15	1.0
	SINE CPS —2DB	....	2—700 KC	20—150 KC	0—200 KC	0—200 KC	0—600 KC	0—180 KC	0—200 KC	0—150 KC
	PULSE RISE μs	....	0.5	....	2	1	0.4	1.8	1.8	3
LINEAR TIME BASE	RANGE IN CPS	80—800 KC	8—800 KC	10—50 KC	3—50 KC	5—50 KC	0.5—50 KC	0.5—50 KC	0.5—50 KC	0.5—50 KC
	TYPE	REP—TR—A—R	REP—TR	REP	REP	REP—TR	REP—TR	REP—TR	REP—TR	REP—TR
CASE	SIZE (APPROX.)	17x9x11	13x16x14	10x4x6	11x5x7	9x19x7	14x19x21	12x6x7	12x6x7	12x6x7
	WEIGHT	31.5	60	5	8¾	30	110	12¾	14	16¼
POWER	INPUT—WATTS	150	215	23	43	80	330	50	70	75

RAYONIC C-R TUBES (Available in P1-P2-P7 and P11 Phosphor)

3 SP

3 MP

TYPICAL OPERATION

TUBE	VOLTS ANODE #2	VOLTS ANODE #1	VOLTS GRID #1	V/IN D1, D2	V/IN D3, D4	MAX. VOLT ANODE #2	MAX. VOLT ANODE #1	VOLTS HEATER	CURRENT HEATER
3SP	1000	165 to 310	—28 to —67	73 to 99	52 to 70	2750	1100	6.3	.6 Amp.
	2000	330 to 620	—58 to —135	146 to 198	104 to 140				
3MP	1000	200 to 350	0 to —68	140 to 190	130 to 180	2500	1000	6.3	.6 Amp.
	2000	400 to 700	0 to —126	280 to 380	260 to 360				

For further information write to

WATERMAN PRODUCTS COMPANY, INC.

PHILADELPHIA 25, PA., U. S. A.

Cable Address
Poketscope
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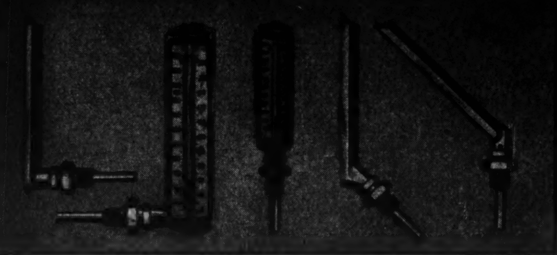
WATERMAN PRODUCTS

MOELLER INSTRUMENT COMPANY

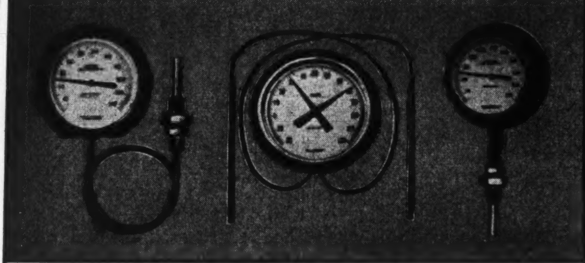
SINCE 1867

132nd STREET & 89th AVENUE, RICHMOND HILL, NEW YORK, N.Y., U.S.A.

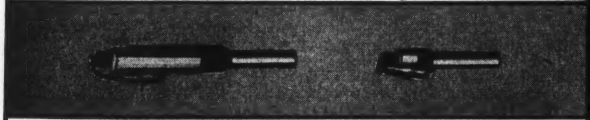
Representatives in Principal Cities



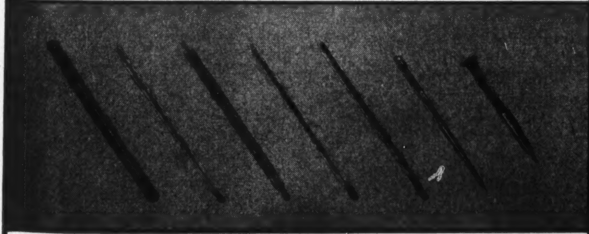
MOELLER INDUSTRIAL THERMOMETERS made in all forms, Straight, Angle, Right Side Angle, Left Side Angle, Reclined and Inclined Angles, in scale ranges from minus 120 to plus 1125°F. or its equivalent in centigrade. Available in 5″, 7″, 9″ and 12″ scale sizes with plain stems, union connection stems and separable sockets in all stem lengths and alloys.



DIAL INDICATING THERMOMETERS, Mercury Actuated, made in 4½″, 6″ and 8½″ sizes with flexible extension tubing. Adjustable rigid stems, single or two pointers, plain bulb, union connection bulb or separable sockets in all lengths and alloys. Scale ranges from minus 40 to plus 1000°F. or its equivalent in centigrade.



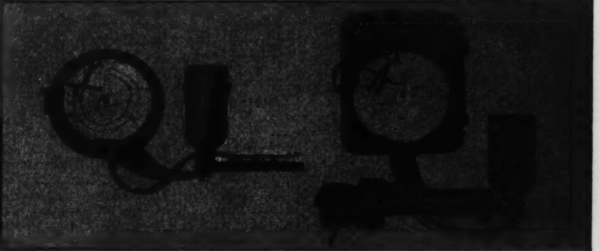
THERMOMETER TEST WELLS, THERMOCOUPLE PROTECTING TUBES and WELLS, made up in all sizes and alloys.



ENGRAVED STEM and PORCELAIN and PAPER SCALE THERMOMETERS made in ranges from minus 150 to plus 1125°F. or its equivalent in centigrade. Available in standard and extreme precision grade. Made to meet specifications of the Government, A.S.T.M. and other authoritative bodies.

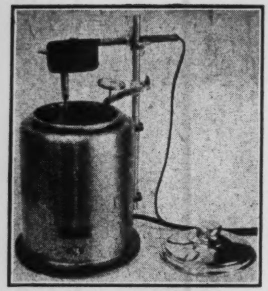
RECORDING THERMOMETERS, Mercury Actuated, made in the round or rectangular cases. Charts 10″ or 12″, 1 hour, 12 hour, 24 hour or 7 day. Ranges from minus 40 to plus 1000°F. or its equivalent in centigrade. Made in remote reading, direct reading, portable and self contained styles. Plain stems, union connection stems and separable sockets in all stem lengths and alloys.

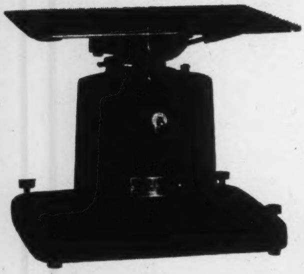
MOELLER BI-METAL THERMOMETERS are actuated by a powerful, specially processed bi-metal helix. Made with 5″ diameter black crackle finish cast brass case. Rigid stainless steel stems, can be furnished with union connection bulb or separable sockets. 4½″ diameter dial with scale ranges from minus 100°F. to 750°F.

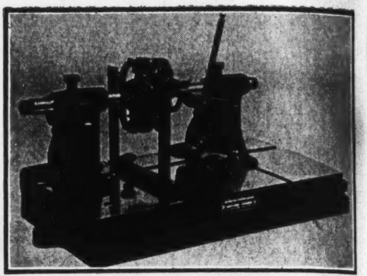


RECORDING PSYCHROMETERS, Mercury Actuated. Round and Rectangular Case, 12 hour, 24 hour or 7 day charts, self contained or remote reading, with or without motor driven fan.

HYDROMETERS PLAIN FORM or COMBINED with THERMOMETER. Made in all scales specific Gravity or Baume for heavy and light liquids. Brix, Twaddle, Ballings Scales, etc. available for all liquids. Standard and commercial grades.

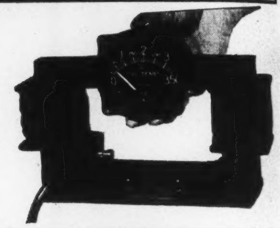




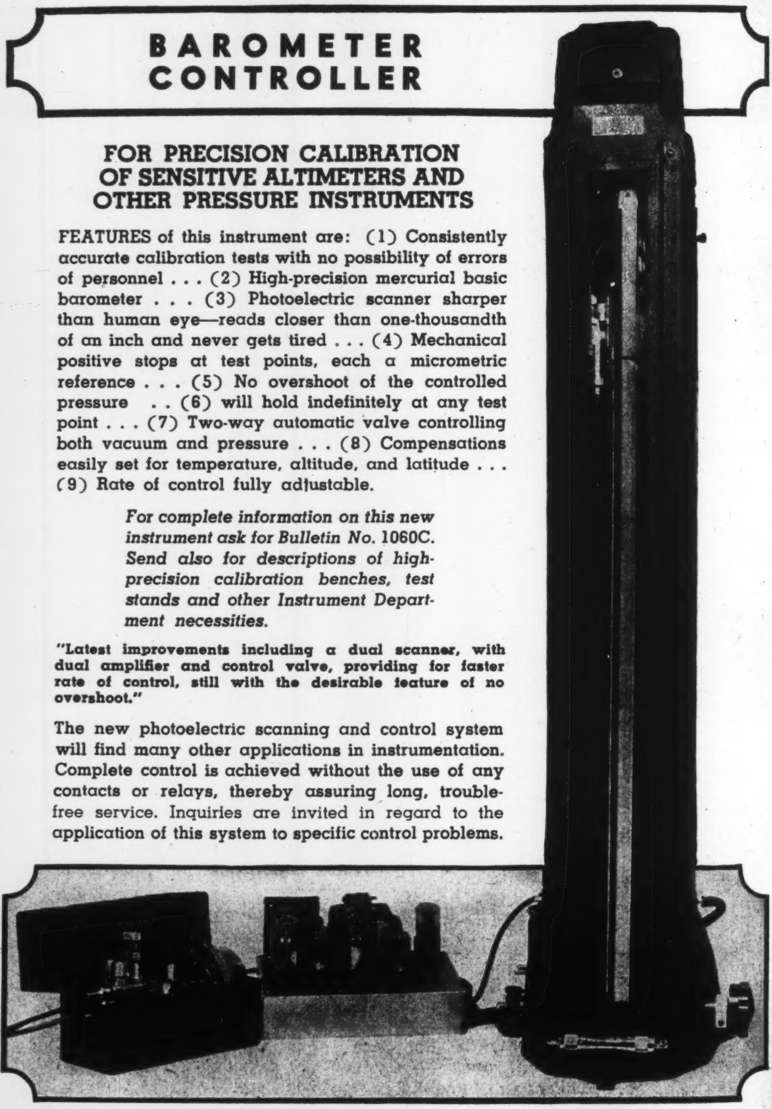


MANY INDUSTRIES

outside of aviation find that our unique test and calibration equipments possess exclusive features.

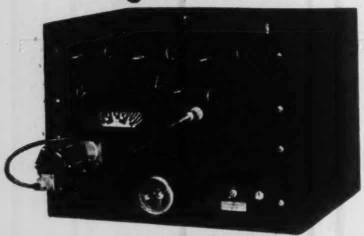


BAROMETER CONTROLLER



FOR PRECISION CALIBRATION OF SENSITIVE ALTIMETERS AND OTHER PRESSURE INSTRUMENTS

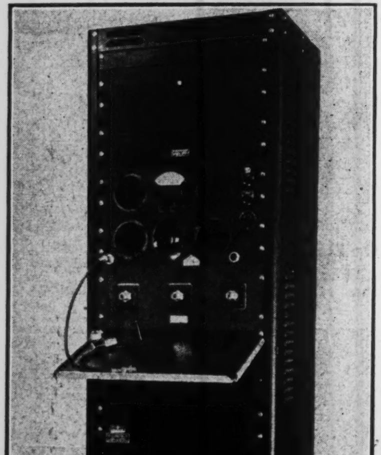
FEATURES of this instrument are: (1) Consistently accurate calibration tests with no possibility of errors of personnel . . . (2) High-precision mercurial basic barometer . . . (3) Photoelectric scanner sharper than human eye—reads closer than one-thousandth of an inch and never gets tired . . . (4) Mechanical positive stops at test points, each a micrometric reference . . . (5) No overshoot of the controlled pressure . . (6) will hold indefinitely at any test point . . . (7) Two-way automatic valve controlling both vacuum and pressure . . . (8) Compensations easily set for temperature, altitude, and latitude . . . (9) Rate of control fully adjustable.



For complete information on this new instrument ask for Bulletin No. 1060C. *Send also for descriptions of high-precision calibration benches, test stands and other Instrument Department necessities.*

"Latest improvements including a dual scanner, with dual amplifier and control valve, providing for faster rate of control, still with the desirable feature of no overshoot."

The new photoelectric scanning and control system will find many other applications in instrumentation. Complete control is achieved without the use of any contacts or relays, thereby assuring long, trouble-free service. Inquiries are invited in regard to the application of this system to specific control problems.



IDEAL LABORATORY TOOL & SUPPLY CO.

3913 EVANS AVE. **CHEYENNE, WYO.**

Rockwell Equipment

for precise measurement and control

Meters for Gas, Water, Oil and other Liquids; Gas Pressure Regulators

DOMESTIC GAS METERS

Made in nine sizes, with capacities ranging from 150* to 500* cfh. Several of the smaller sizes have pressure cast aluminum alloy housings—others are cast iron or tin. Designed to cut maintenance costs.

**Meters rated for 0.60 sp. gr. gas at ½″ pressure drop.*

LARGE CAPACITY GAS METERS

Made in both cast iron and pressed steel types. Five models with capacities ranging from 1,800* to 10,000* cfh. Can be furnished with either Combined Record Gauges or the Emcorector to convert gas measured at high pressures to a low base pressure.

**Meters rated for 0.60 sp. gr. gas at 2″ pressure drop.*

FLOW INDICATING METERS

Especially designed to measure flow rates when setting, adjusting or testing appliances. Also useful in laboratories. Reads directly in cfh. Special scales are available. Three sizes, with capacities ranging from 0-2.5 cfh. to 0-500 cfh.

ORIFICE METERS

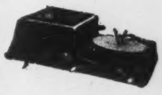
Measure accurately over a wide range of pressures and volumes by the orifice plate differential principle. Feature leak-proof Teflon stuffing box, positive inking pens, interchangeable high side chambers. Models available for 20″, 50″, 100″, 200″, 300″ and 400″ differential.

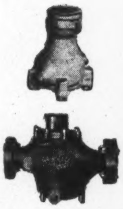
CHART DRIVES

Dependable, convenient timing drives for meters, controls, recorders. Two models, the Midget for use in instruments where space is at a premium; the Standard for replacement service. Simple speed changing turrets assure flexibility in application.

ORIFICE CHART INTEGRATORS

The operator of a Rockwell integrator mechanically computes the total extension of flow meter charts by retracing the differential and static chart records as made by the meter. This total appears on a direct reading counter.



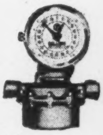


WATER METERS

The most complete range of sizes and models made. Types include oscillating piston, disc, current, and compounds. Straight reading or circular registers optional. Sizes ⅝″ to 6″—capacity range from 20 gpm to 1600 gpm.

INDUSTRIAL METERS

Rockwell industrial meters provide dependable quantitative records of liquids used in batching, blending, processing. These meters are also used for formula and cost control. Practically any liquid that can be piped can be metered. Sizes ½″ to 3″.



GASOLINE AND OIL METERS

Rockwell makes a complete line of petroleum meters for guarding and guiding the flow from well head to service station pump. Types include production, pipeline, loading rack, tank truck and dispensing pump meters. Sizes from ½″ to 6″.

APPLIANCE REGULATORS

Provide highest burner efficiency, prevent pilots from being extinguished on all types of gas burning appliances. Sizes ⅛″ through 3″.

SERVICE REGULATORS

Reduce distribution line pressures in psi to controlled utilization pressures in inches of water. Two models, sizes ¾″, 1″, 1¼″, 1½″ and 2″.

BALANCED VALVE REGULATORS

With Instrument Control

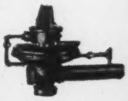
One of a complete selection of high and low pressure large volume regulators. Instrument control permits precise setting and pressure response. Other standard controls include pilot loading, spring loading, lever and weight. Low pressure regulators are either inside or outside weighted. Sizes 2″ to 12″.

INDUSTRIAL REGULATORS

The Rockwell "120" controls outlet pressures from 1 psi to atmospheric pressure or less with inlet ranging up to 5 psi. Sizes ¾″ to 6″.

"1001" REGULATORS

A general purpose control. Reduces inlet pressures of 200 psi or less to outlet range of 2 oz. to 60 psi depending on spring selected and setting. Size 2″ only.



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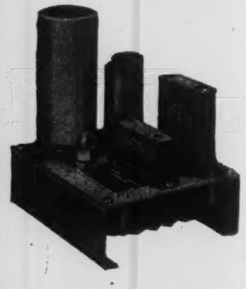
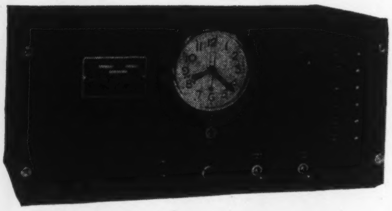


TYPE 2001-2, BASIC UNIT

Frequencies 200 to 2500 cycles. Dividers and Multipliers available for lower and higher frequencies. Miniaturized and JAN construction. Output, 6 volts.

TYPE 2005, UTILITY UNIT

Consists of Type 2001-2 and booster to provide 10 watts at 110V at precision frequencies from 50 to 500 cycles at input power frequencies of 50 to 500 cycles, 45 watts.



TYPE 2121-A, LAB. STANDARD

Outputs, 60 cycle, 0-110 Volts, 10 Watts; 120-240 cycle impulses. Input, 50-400 cycles, 45 Watts.

Precision FREQUENCIES

GUARANTEED ACCURATE

TO 1 PART IN 100,000 (.001%)

TYPE 2111, POWER UNIT

50 Watt output. 0-110-220V at 60 cycles, or any frequency 50 to 1000 cycles. Input, 50-100 cycles, 275 watts.

THE basis of these frequency standards is an electronic fork which is temperature-compensated and hermetically sealed against humidity and barometric pressure.

Type 2001-2 and similar units are available independently. Complete instruments of our manufacture are used extensively by industry and the armed forces where unvarying, dependable high precision is required, such as for bombsights and fire control.

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Radiation Counting
Fluid Flow
Chemical Reaction
Navigation
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Accurate Speed Control

WHATEVER YOUR FREQUENCY PROBLEMS, OUR ENGINEERS ARE READY TO COOPERATE. PLEASE REQUEST DETAILS BY TYPE NUMBER.

American Time Products, Inc.

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400 CYCLE POWER
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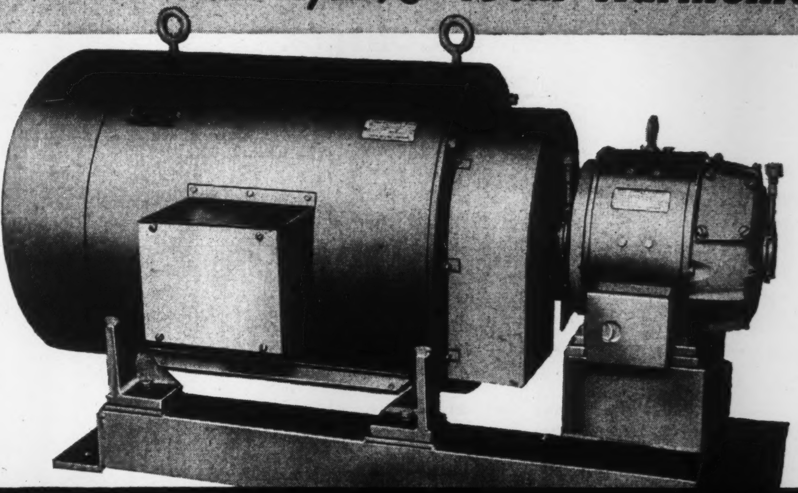

★ For use in Laboratory and Production testing of high performance electronic equipment Bogue has developed a line of single and three phase 400 Cycle Synchronous Motor-Generator Sets ranging from 3 to 100 KW with total harmonic content less than 1/2% This extreme quality in wave form is secured thru precision design, careful selection of material and quality control in manufacture.

Special units with less than 1/10% total harmonics available.

These sets can also be furnished with magnetic amplifier static voltage regulators when the utmost in reliability and constancy in voltage regulation is required. Output frequency is exactly 400 cycles at any load—no load to full load!

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AC & DC GENERATORS • VOLTAGE & SPEED REGULATORS • SWITCHBOARDS

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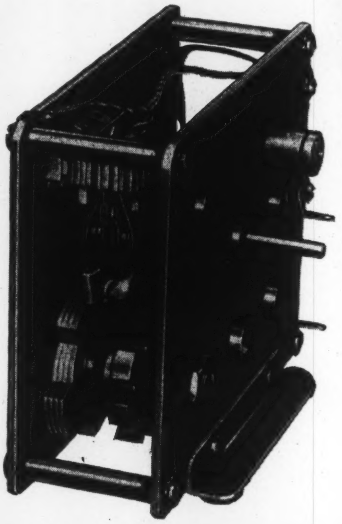
....WITH AC ACCURACY

FOR ACCURATE TIMING CONTROL FROM BATTERIES OR DC LINE



SPEED
Magnetic reed drive provides constant speeds with instantaneous self-start to full speed. Speeds from 1 REV. PER DAY to 900 REV. PER MINUTE.

SIZE
3½" x 2½" x 1⅝", wght.—10 oz. and 2" x 3½" x 3¾" wght.—15 oz.

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From 3 to 110 Volts. These units are custom built to your requirements: voltage—current—speed—torque.

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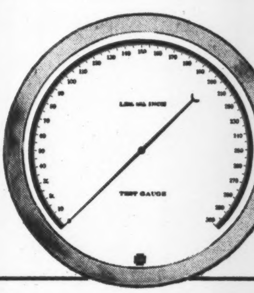
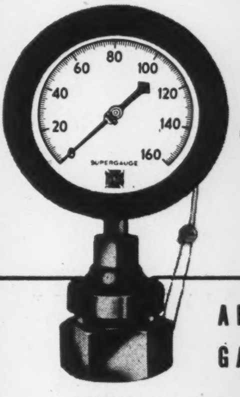
Accuracy—½ of 1% of the indicated reading above 20% of the maximum dial range and 0.2% of full scale over balance. Furnished with Certified Test Report. Sensitivity as high as 1 part in 10,000. Ranges 15 to 20,000 p.s.i. standard; special 30,000 p.s.i. or over.





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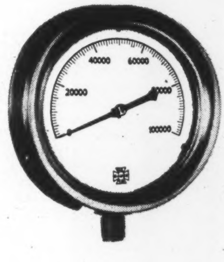
Cleanout and protected types. Cleanout type used for viscous liquids requiring periodic cleaning; protected type designed for low-viscosity liquids. These gauges are rugged, will stand high overpressure. Ranges 30" vacuum to 1500 p.s.i.



HIGH PRESSURE SOLID FRONT GAUGES

For testing high pressure gases and liquids. Built to highest possible standards. Accuracy 1% of full scale reading up to 50,000 p.s.i., 2% of full scale reading on pressures over 60,000 p.s.i. Ranges 100 to 150,000 p.s.i.

ABSOLUTE PRESSURE GAUGE

A highly accurate, dependable instrument for measuring absolute pressures. Ranges: 0 to 20 millimeters to 10 to 100 inches of mercury.

2
4
6
8
10
12
14
16
18
20

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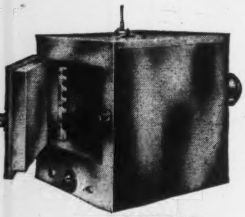
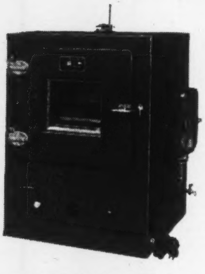


ECONOMY
FORCED
DRAFT OVEN



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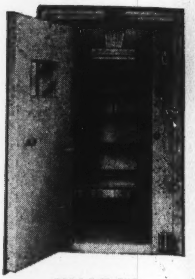

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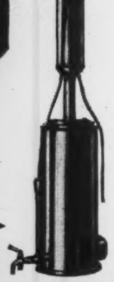

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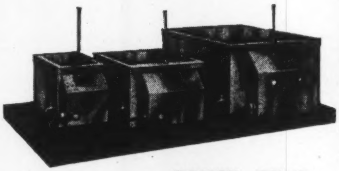

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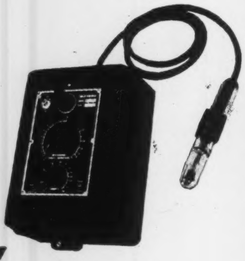

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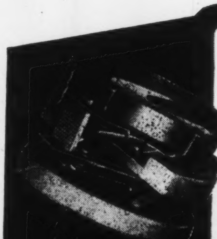

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MORE and more designers are finding the Bell Switch just what they need to solve their control problems. The Bell Switch is a 100% positive snap action, magnetic proximity switch that is adaptable to any application where switch must be actuated through sealed barriers. Among the many applications in which it has been so successfully employed are cutoffs for all kinds of systems, counting devices, signal alarms and operation of automatic machinery. In addition to standard models, the Bell Switch is available in immersion-proof and splash-proof models to meet the demands of even the most severe services.

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The 1952 Instruments Index

THIS issue of the INDEX has been compiled to meet the need of users of instruments and devices for measurement, inspection, testing and control, for a purchasing directory of such equipment. Since the 1950 INDEX, 249 companies' names and products, which have not appeared previously, were included; the names of 95 companies appearing in former issues of the INDEX have been removed; 278 name and address changes have been made. The INDEX is the most complete directory of instruments and devices for measurement, inspection, testing and control ever published. The number of companies included increased from 1363 in the 1950 INDEX to 1517 in this issue.

This directory is arranged, indexed and cross-indexed to make its contents easily available.

***The Index Section*—"Who makes what"—is the most important. Anyone who wants to know where he can buy or secure information on a certain product will find the product properly indexed and cross-indexed, and under it the names of the manufacturers of this equipment and manufacturers' sole representatives.**

***Indexing System.* Products are indexed under the main word. In cases where a name is ambiguous, or where the item is known under two or more names, companies making such devices are listed under one heading and cross-references inserted under the other headings.**

***Specific Terms.* You never are in need of "a gage", but of some particular kind of gage. Therefore we do not list manufacturers under broad general designations. For example, we do not list any names under the main heading "Meters" but we give the sources of supply for numerous classes and types of meters. Moreover, we do not list any names under "Meters, Liquid" alone, but we give under proper subheads the sources of supply for the *class* and *type* of liquid meter you may need.**

***Correctness of Headings.* As explained above, main headings and subheads are technically correct. A few are not scientifically correct: they are names in common usage, recognized for the convenience of the majority.**

***Correctness of Listings.* A few of the companies listed and advertising in the INDEX you already know. All of them are actively engaged in the manufacture of instruments and devices for measurement; inspection, testing and control. We have endeavored to list no firm names under specific headings unless the instruments made by such firms belong there by virtue of their design and construction. As a rule, we have to take the company's word that it could supply the product in question.**

***Completeness.* More than 1600 manufacturers were canvassed in the last four months. In the last few weeks we sent representatives to call on manufacturers. Therefore, the omission of any manufacturer's name under any heading is due to the negligence of someone in his own organization.**

Every effort has been made to restrict the names in the Index Section to (1) the actual manufacturers and (2) the sole authorized sales agencies. On the other hand, whenever you desire to order at one time a variety of equipment made by different firms, you may find it most convenient to get in touch with a recognized, competent, "laboratory supply house." These houses are listed under *"Apparatus, Laboratory."*

***Instruments' Further Service.* This Index contains the answers to *only 99%* of your inquiries. If you cannot find the product or the name you want, communicate with the Information Section, Instruments Publishing Co., 921 Ridge Ave., Pittsburgh 12, and every effort will be made to furnish the information promptly.**

***Suggestions.* We shall appreciate suggestions regarding:**

1. **Headings not at present found in this Index which should be there,**
2. **Firms listed erroneously, and**
3. **Other inaccuracies which may have crept in despite all precautions.**

Use this INDEX consistently. You will find the companies listed herein equipped to render the kind of service which saves time and helps make satisfied customers.

Where companies in whose products you are interested have omitted descriptions, your cooperation is invited in bringing this to the attention of the supplier or the publisher. Also, whenever the INDEX has aided you, please inform the manufacturer that his data in THE INSTRUMENTS INDEX were of help to you.

INDEX SECTION

ABRASION MACHINES (See Testers, Abrasion)

ABSOLUTE PRESSURE INDICATORS (See Gages, Absolute Pressure)

ABSORPTIOMETERS
Biddle Co.
Brabender Corp.
Jarrel-Ash
Photovolt Corp.
Rubicon Co.

ACCELEROMETERS
Aero Electronics
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Alfax Paper & Engg.
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Vectron, Inc.
Vibration Specialty
Waugh Labs.
Wiancko Engineering

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Engineering Res. Assoc.
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Gulton Mfg. Co.
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Pacific Div.
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Van Dyke Insts.
Vectron, Inc.
Wiancko Engineering

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Commercial Research
Doelcam Corp.
Flader Inc., Fredric
Flight Research Eng.
Giannini & Co.
Hathaway Inst. Co.
Kollsman Inst. Div.
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Summers Gyroscope
Statham Labs.
Trans-Sonics, Inc.
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Massa Laboratories
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Rieker Inst. Co.
Rubicon Co.
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Schultheis Corp.
Tagliabue Div.
Taylor & Co., W. A.
Thwing-Albert Inst. Co.
Uehling Instrument Co.

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Breeze Corp.
Cleveland Fuel Equip.
Engr. Research & Dev.
Globe Industries
Oster Mfg., John
Schwien Engr.

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Automatic Products
Eclipse-Pioneer Div.
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General Electric
Hagan Corp.
Hammel-Dahl Co.
Hydraulic Controls
Infilco Inc.
Leupold & Stevens
Martin-Hubbard Corp.
Republic Flow Meters

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Alfax Paper & Eng.
Eclipse-Pioneer Div.
Instruments Corp.

AEROMETERS
Friez & Sons

AIR ANALYSIS APPARATUS (See Gas Analyzers, Air)

AIR COMPRESSORS, Instrument
Ingersoll-Rand
Nash Engineering

AIRCRAFT FLIGHT ANALYZERS
Aero Electronics
Aircraft Electronics
Autoflight Insts. Div.
Century Geophysical
Doelcam Corp.
Electronic Associates
Flader Inc. Fredric
Farrand Optical
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AIR FLOW METERS (See Flowmeters, Gas)

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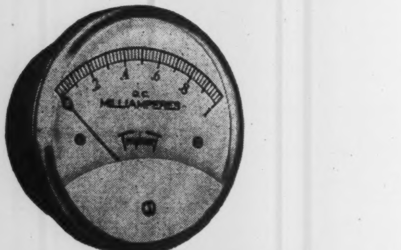

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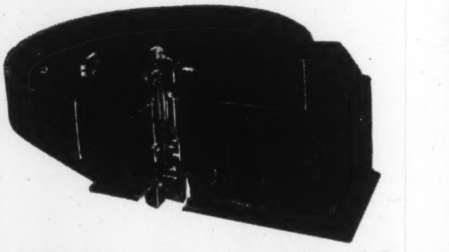

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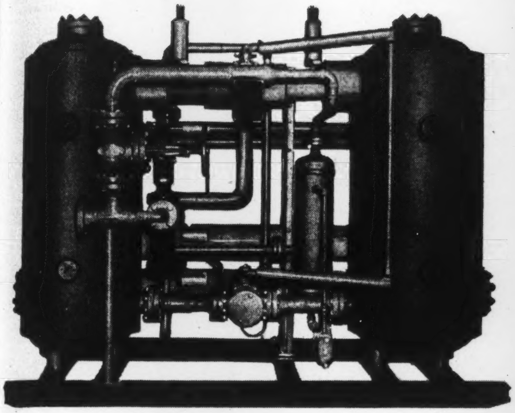

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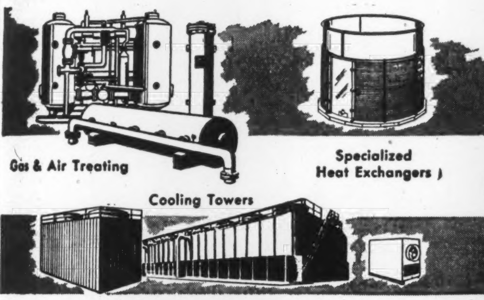

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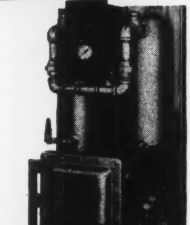

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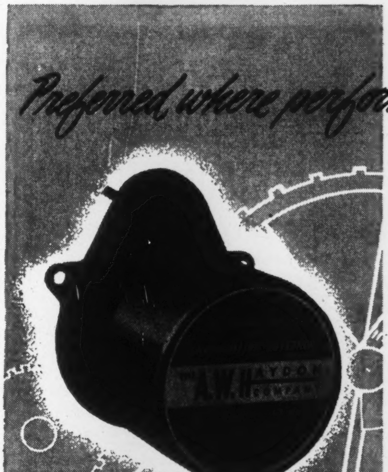

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ALARMS, Carbon Bisulphide

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Wright-Austin Co.
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Bruning Co.
RCA Div.
Stratex Instrument Co.
Wallace & Tiernan

ALTITUDE BAROMETERS (See Barometers, Altitude)

AMMETERS, A-c. Multi-range

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Burlington Instrument
Dittmore & Freimuth
General Electric
International Inst.
Precision Apparatus Co.
Rawson Elec. Inst.
Roller-Smith
Simpson Electric Co.
U. S. Gauge Co.
Welch Scientific
Westinghouse Elec.

AMMETERS, Clamp Type

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Dale Instruments
Electronic Development
Ferranti Electric
General Electric
U. S. Gauge
Weston Elec. Inst.

AMMETERS, Contact-making

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General Electric Co.
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Lewis Engineering
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Triplett Elec. Inst.
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Cambridge Inst. Co.
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Dittmore & Freimuth
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Welch Mfg. Co
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AMMETERS, Laboratory Standard

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Welch Scientific
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AMMETERS, Microammeters, A-c Rectifier

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Burlington Instrument
Dale Instruments
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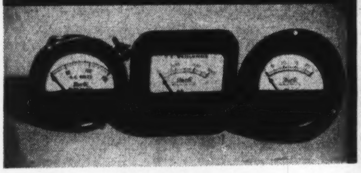

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HD Elec. Co.
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Weston Elec. Inst. Corp.

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Rawson Elec. Inst.
Roller-Smith
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Metron Instrument
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Photron Instrument
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McFarlin Co.
Millen Mfg. Co.
Millivac Instruments
Minnesota Electronics
Perkin Elmer Corp.
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Raytheon Mfg. Co.
RCA Div.
Reeves Instrument
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Rockwell Engr.
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Sherron Metallic
Southwestern Ind. Elec.
Summers Gyroscope
Techno Inst.
Tektronix, Inc.
Thordarson Elec. Mfg.
Transmitter Equipment
Varo Mfg. Co.
Walkirt Co.
Waterman Products
West Coast Electronics
Wilson & Co.
Yellow Springs Inst.

AMPLIFIERS, Geophysical
Aero Electronics
Century Geophysical
Heiland Research
Midwestern Geophysical
Southwestern Ind. Elec.
Photron Instrument

AMPLIFIERS, Linear
Aero Electronics
Antenna Research Lab.
Century Geophysical
Consolidated Engr.
Electro-Mech. Research
Engr. Research & Dev.
Feiler Engineering

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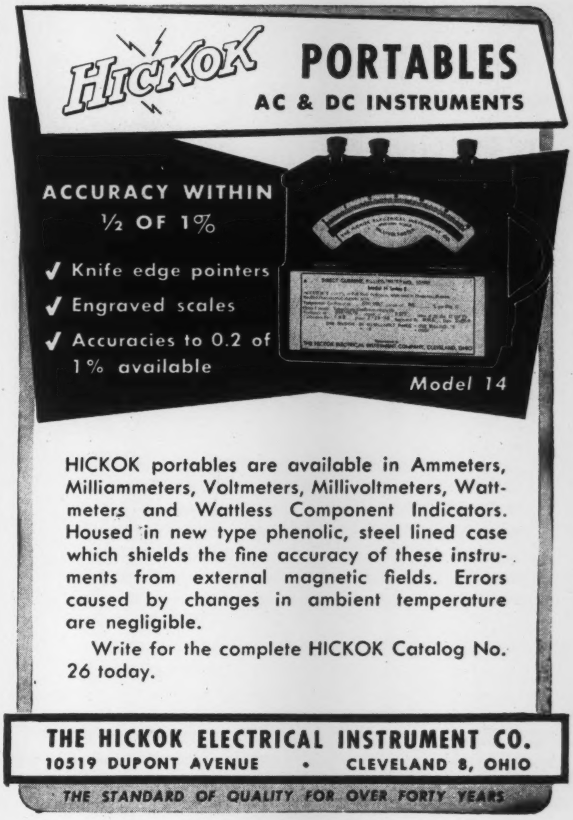

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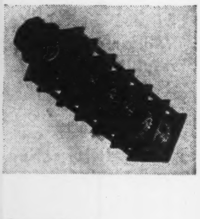

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Tracerlab

AMPLIFIERS, Radio Frequency

Antenna Research Lab.
Audio Development
Browning Labs.
Clarke Inst. Corp.
Collins Radio Co.
Concord Radio Corp.
Electro-Mech. Research
El-Tronics, Inc.
Engineering Res. & Dev.
Feiler Engineering
Ferris Inst. Corp.
General Elec. Co.
Geophysical Inst. Co.
Harvey Radio Labs.
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Raytheon Mfg. Co.
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Rowe Engineering
Servo Corp. of America
Sherron Metallic
Sperry Gyroscope Co.
Sylvan Electronic Labs.
Tektronix, Inc.
Triumph Mfg. Co.
Waterman Products
West Coast Electronics

AMPLIFIERS, Vibration

Aero Electronics
Century Geophysical
Consolidated Engr.
Dice Co., J. W.
Electro-Products Labs.
Engr. Research & Dev.
Feiler Engineering
Furst Electronics
Gulton Mfg. Co.
Heiland Research
Industrial Electronics
Midwestern Geophysical
Scott Inc., H. H.
Southwestern Ind. Elec.
Sperry Gyroscope Co.

AMPLIFIERS, Wideband

Electro-Mech. Research
Electronic Instrument
Engr. Research & Dev.
Feiler Engineering
Furst Electronics
General Radio Co.
Hewlett-Packard
Kalbfell Labs.
Marconi Inst. Ltd.
Polarad Electronics
Technology Inst. Corp.

ANALYZERS, Chemical Composition, Recording & Controlling

Aero Electronics
American Inst. Co.
Applied Physics Corp.
Applied Research Labs.
Baird Associates
Beckman, Inc., Arnold O.
Cambridge Instrument
Coleman Electric Co.
Consolidated Engg.
Davis Emergency Equip.
Dietert Co., Harry W.
Edin Electronics
Fisher Scientific Co.
Friez Inst. Div.
General Elec. Co.
Industrial Instruments
Laboratory Equip. Corp.
Leeds & Northrup Co.
Macbeth Corp.
Machlett & Son, E.
Mine Safety Appliances
National Technical Labs.
Patwin Inst. Div.
Phillips Petroleum
Podbielniak, Inc.
Rowe Engineering
Rubicon Co.
Sargent & Co., E. H.
Scientific Glass App.
Skaneateles Mfg.
Tagliabue Div.

ANALYZERS, Electric Wave

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General Electric
General Radio Co.
Hewlett-Packard
Kay Electric Co.
RCA Div.
Scott, Inc, Hermon
Techno Inst.
Wilmotte, Inc.

ANALYZERS, Electronic Circuit

Bradshaw Instruments
Dale Instruments
Electronic Development
General Electric
National Tech. Labs.
Precision Apparatus Co.
RCA Dev.
Westinghouse Elec.
Weston Elec. Inst.

ANALYZERS, Flight

Aero Electronics
Aircraft Electronics
Century Geophysical
Edin Electronics
Flight Research Eng.
General Electric
Genisco Inc.
Hathaway Instrument
Reeves Instrument
Techno Inst.

ANALYZERS, Gas (See Gas Analyzers)

ANALYZERS, Infrared

Applied Physics Corp.
Baird Associates
Liston-Folb
Mine Safety Appliances
Perkin-Elmer Corp.

ANALYZERS, Ignition System

Fox Valley Inst.
Hickok Elec. Inst.

ANALYZERS Industrial Circuit Tester

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Bradshaw Instruments
Cincinnati Clock
Dale Instruments
Electronic Development
Feiler Engineering
Flight Research Eng.
General Electric
Instruments Labs.
Precision Apparatus
Roller Smith
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst.

ANALYZERS, Industrial Power

Cincinnati Clock
Cole Instrument
Edin Electronics
Elec. Facilities, Inc.
Electro-Products Labs.
Electro-Tech. Equip.
Esterline-Angus
General Electric
Instrument Labs.
Sticht Co., Herman
Triplett Elec. Inst.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

ANALYZERS, Radio Set

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Amerline
Audio-Tone Oscillator
Bradshaw Instruments
Chicago Indust. Inst.
Clough-Brengle Co.
Communication Meas. Lab.
Dale Instruments
Electronic Development

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Kepco Labs.
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RCA Mfg.
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Triplett Elec. Inst. Co.
Triumph Mfg. Co.
Universal Inst. Co.
Waterman Products Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

ANALYZERS, Sound

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Clough-Brengle Co.
Electro Products Lab.
Electronic Associates
Engineering Res. & Dev.
Feiler Engineering
General Elec. Co.
General Radio Co.
Hewlett-Packard
Hickok Elec. Inst. Co.
Kay Electric
Minnesota Electronics
RCA Manufacturing Co.
Scott, Inc., Hermon
Techno Inst.
Western Electric
Westinghouse Elec.
Weston Elec. Inst.

ANEMOMETERS, Hot-wire

Friez Inst. Div.
Hastings Inst. Co.
Serdex, Inc.
Victory Engr.
Willson Products, Inc.

ANEMOMETERS, Mechanical.

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American Inst. Co.
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Dietzgen Co.
Eclipse-Pioneer Div.
Flight Research Eng.
Friez Instrument
Geophysical Inst. Co.
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Wilson Products, Inc.

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Sorenson & Co.

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Callahan & Co.
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Erb & Gray
Ervin Co.
Fassett Co.
Feiler Engineering
Ferguson Co.
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Freed, J. Melvin
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Standard Scientific
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Inst. Development Labs.
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Phoenix Prec. Inst.
Stoelting Co., C. H.
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Ultra-Violet Products
Uhrig Co., Joseph
Unertl Optical Co.

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Belco Laboratory
Boehmke Optical Co.
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Burrell Tech. Supply
Central Scientific Co.
Century Geophysical
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Tagliabue Div.
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Thomas Co., Arthur H.
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Universal X-Ray Prods.
Walker & Co., Geo. T.
Welch Scientific
Wilkens-Anderson Co.
Will Corporation

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Eclipse-Pioneer Div.
General Elec. Co.
Reeves Instrument
Schwien Engg. Co.
Sperry Gyroscope Co.
Summers Gyroscope

ASPHALT PENETRATION NEEDLES (See Needles Asphalt Penetration)

ASPHALT TESTING APPARATUS (See Testers, Asphalt)

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Eastern Science Co.
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Lenox Inst. Co.
Mann Co., W. I.
Mico Instrument Co.
Mogey & Sons
Perkin-Elmer Corp.
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Schwien Engr.
Taylor Inst. Cos.
Tinsley Labs.
Unertl Optical Co.
Warren-Knight Co.
White Co.
Carl Zeiss, Inc.

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Daven Co.
Electro Products Lab.
Feiler Engineering
General Radio Co.
Harvey Radio Labs.
Hewlett-Packard Co.
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International Resistance
Kay Electric Co.
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Ohmite Mfg. Co.
Polytechnic Res. & Dev.
RCA Div.
Reiner Electronics
Scott, Inc., Hermon

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Shallcross Mfg. Co.
Sherron Metallic
Sound Apparatus
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American Communications
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Assembly Products
Audio Development Co.
Audio Instrument
Audio-Tone Oscillator
Baird Associates
Ballantine Labs.
Bark's Mfg. Co.
Beam Instrument
Berkeley Scientific
Boonton Radio Corp.
Browning Labs.
Brush Development
Century Geophysical
Cinema Engr.
Clark Radio Equip.
Clarke Inst. Corp.
Clarkstan Corp.
Clough Brengle Co.
Collins Radio Co.
Commercial Research
Concord Radio Corp.
Daven Co.
Eclipse-Pioneer Div.
Edin Electronics
Electro-Mech. Research
Electro-Medical Lab.
Electro Products Lab.
Electronic Design Corp.
Electronic Dev. Lab.
Electronic Prod. Co.
El-Tronics, Inc.
Engineering Res. & Dev.
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Federal Telephone
Feiler Engineering
Freed Transformer
General Elec. Co.
General Radio Co.
Geophysical Inst. Co.
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Harvey Radio Labs.
Helland Research
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Lewyt Metal Prod.
MacLeod & Hanopol
Martin-Hubbard Corp.
Massa Laboratories
McFarlin Co.
Measurements Corp.
Mellaphone Corp.
Metron Instrument
Millen Mfg. Co.
Minnesota Electronics
National Co.
Polarad Electronics
Premier Crystal Labs.
Radio Receptor Co.
Rauland Borg Corp.
Raytheon Mfg. Co.
RCA Div.
Reiner Electronics
Scott, Inc., Hermon
Shallcross Mfg. Co.
Sherron Metallic
Sound Apparatus
Southwestern Ind. Elec.
Standard Transformer
Sylvania Elec. Prod.
Technology Instrument
Televiso Co.
Thordarson Elec. Co.
Triumph Mfg. Co.
United Sound Eng. Co.
United Transformer Corp.
Westinghouse Elec.

AUDIO-FREQUENCY OSCILLATORS (See Oscillators, Audio-Frequency)

AUDIOMETERS
Marconi Insts. Ltd.
Scott, Inc., H. H .
Stoelting Co., C. J.

AUTOCLAVES, High-Pressure
American Instrument
Parr Instrument
Precision Scientific
Ruska Inst. Corp.

AUTO-COLLIMATORS
Acme Industrial
American Inst. Co.
Clark & Sons
Dome Precision
Dusenberg Co.
Engis Equipment
Farrand Optical
Fecker, J. W.
Gaertner Scientific
Geophysical Inst. Co.
Jarrell-Ash Co.
Kollmorgen Optical Co.
Mann Co., W. I.
Optical Ser. & Dev.
Palos Optical Co.
Perkin-Elmer Corp.
Unertl Optical Co.

AUTOMATIC (See Controllers or Regulators)

AUTOMOTIVE SERVICE INSTRUMENTS
Airdraulics Engineering
Bacharach Indus. Inst.
Bear Mfg. Co.
Cambridge Inst. Co.
Cole Instrument

(Continued)

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Engineering Res. & Dev.
Fox Valley Inst.
Hays Corp.
Hickok Elec. Inst. Co.
Kimble Glass
Lewis Engineering
Niehoff & Co.
Potter Co.
Rieker Inst. Co.
Shauer Mfg. Co.
Scott, Inc., Hermon
Triplett Elec. Inst.
Westberg Mfg. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

AVIATION INSTRUMENTS, see also Aircraft; Inclinometers, Lateral; Indicators, Pitch & Bank; Chambers, Test & Calibration, etc.
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Aero Electronics
Aeromarine Inst. Co.
Aeroequip Corp.
Aircraft Indicators Co.
Airdraulics Engineering
American Meas. Inst.
American Paulin System
Bailey Meter Co.
Boonton Radio Corp.
Coleman Instrument
Cook Electric
Daco Machine & Tool
De Jur-Amsco Corp.
Doelcam Corp.
Eclipse-Pioneer Div.
Edison Inc., Thomas A.
Federal Telegraph Co.
Fischer & Porter
Flight Research Eng.
Gadgets, Inc.
General Elec. Co.
Giannini & Co., G. M.
Guardian Elec. Mfg.
Ideal Lab. Tool
Jadur Import
Kollsman Inst. Div.
Lackner Co.
Lewis Engineering
Machlett & Son
Maxson Corp.
North Amer. Inst. Co.
Reeves Instruments
Revere Corp.
Rochester Mfg. Co.
Schwien Eng.
Sperry Gyroscope Co.
Standard Products Inc.
Summers Gyroscope
Televiso Co.
Trimount Inst. Co.
Triplett Elec. Inst.
U. S. Gauge
Wallace & Tiernan
Westinghouse Elec.
Weston Elec. Inst.
Wheelco Instruments
White & Co., David
Wiancko Engineering
Winslow Co.

AZIMUTH INSTRUMENTS
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Dusenbery Co.
Eastern Science Co.
Eastern Specialty Co.
Fecker, J. W.
Flight Research Eng.
Gaertner Scientific Corp.
Hand & Sons
Keuffel & Esser Co.
Kollmorgen Optical Co.
Lear, Inc.
Leupold & Stevens
Negus, T. S. & J. D.
Ritchie & Son
Stafford Co.
Summers Gyroscope
Unertl Optical Co.
Warren-Knight Co.
White Co.

BALANCES (See also object of measurement and control)

BALANCES, Analytical
Ainsworth & Sons
Becker Div., Christian
Central Scientific Co.
Chicago Apparatus Co.
Dietert Co.
Exact Weight Scale Co.
Fisher Scientific Co.
Heusser Instrument
Jarrell-Ash Co.
Microchemical Service
Pfaltz & Bauer, Inc.
Roller-Smith
Seedburo Equipment
Seederer-Kohlbusch, Inc.
Thomas Co., Arthur H.
Thompson Balance
Troemner, Henry
Voland & Sons
Welch Scientific

BALANCES, Assay
Ainsworth & Sons
Central Scientific Co.
Exact Weight Scale
Heusser Instrument
Jarrell-Ash Co.
Roller-Smith
Seederer-Kohlbusch, Inc.
Thompson Balance
Troemner, Henry
Voland & Sons

BALANCES, Automatic Recording
Engineering Res. & Dev.
Roller-Smith
Taller & Cooper
Seederer Kohlbush, Inc.
Voiand & Sons

BALANCES, Bullion
Becker Div., Christian
Exact Weight Scale
Seederer-Kohlbusch, Inc.
Troemner, Henry
Voland & Sons, Inc.

BALANCES, Gas Density
Central Scientific Co.
Exact Weight Scale Co.
Hagan Corp.

Refinery Supply Co.
Thomas Co., Arthur H.

BALANCES, Hydrostatic
Central Scientific Co.
Chicago Apparatus Co.
Seederer-Kohlbusch, Inc.

BALANCES, Jewelers
Becker Div., Christian
Roller-Smith
Seederer-Kohlbusch, Inc.
Troemner, Henry
Voland & Sons, Inc.

BALANCES, Joly's
Central Scientific Co.
Eberbach & Son
Welch Scientific

BALANCES, Magnetic
Exact Weight Scale
Geophysical Inst. Co.
Instrument Lab., Inc.
Seederer-Kohlbusch, Inc.
Voland & Sons

BALANCES, Magnetic (Geophysical)
Century Geophysical
Edin Electronics
Geophysical Inst. Co.
Ruska Inst. Corp.

BALANCES, Micro
Ainsworth & Sons
Becker Div., Christian
Cady & Co., E. J.
Canadian Radium
Central Scientific Co.
Heusser Instrument
Microchemical Service
Mittelman Electronics
Pfaltz & Bauer, Inc.
Thomas Co., Arthur H.
Voland & Sons, Inc.

BALANCES, Precision for Weights & Measures
Ainsworth & Sons
Becker Div., Christian
Burke & James
Cady & Co., E. J.
Central Scientific Co.
Chatillon & Sons
Coleman Inst. & Mfg.
Exact Weight Scale Co.
Heusser Instrument
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Jacobs Bros. Co.
Ohaus Scale Co.
Pfaltz & Bauer, Inc.
Roller-Smith
Seedburo Equipment
Seederer-Kohlbusch, Inc.
Thompson Balance
Troemner, Henry
Voland & Sons, Inc.
Welch Scientific Co.

BALANCES, Pulp
Becker Div., Christian
Central Scientific Co.
Exact Weight Scale
Heusser Instrument
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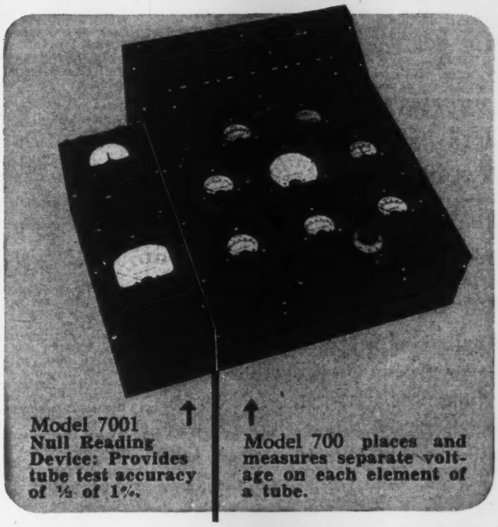

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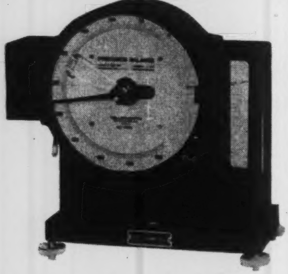

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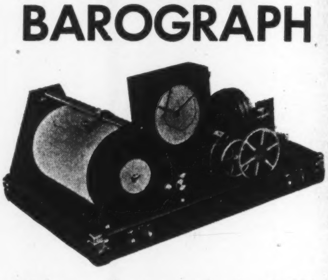

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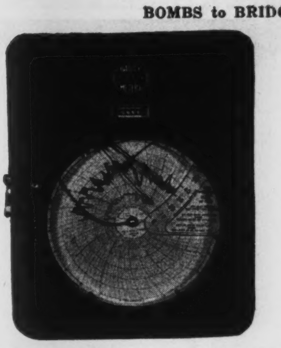

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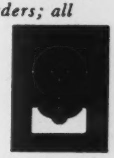

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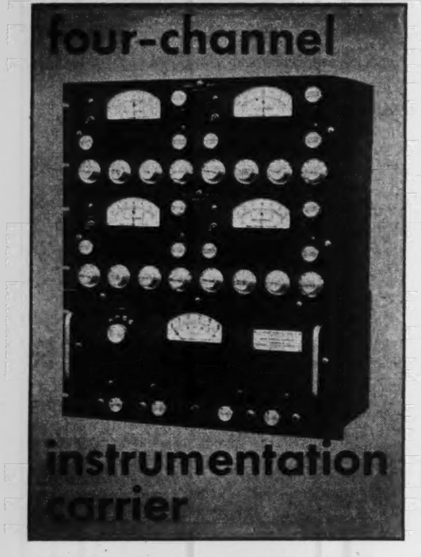

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Thwing-Albert Inst. Co.
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BRIDGES, ELECTRICAL, Vacuum Tube
Central Scientific Co.
Cole Instrument
Crown Ind. Prods.
Eclipse-Pioneer
Electronic Prod. Co.
Electro Products Lab.
El-Tronics, Inc.
Feiler Engineering
Fisher Scientific Co.
General Elec. Co.
General Radio Co.
Harvey Radio Labs.
Industrial Insts. Inc.
Lear, Inc.
RCA Manufacturing
Sylvania Elec. Prod.
Televiso Co.
Thwing-Albert Inst Co
Triumph Mfg. Co.
Wilson & Co.

BRIDGES, ELECTRICAL, Wattmeter
Aerovox Corp.
Freed Transformer Co.
Sperry Gyroscope Co.

BRIDGES, ELECTRICAL Wheatstone
Associated Research
Baldwin-Lima-Hamilton
Beck Bros.
Biddle Co., James
Borden Engineering
Brown Electro-Measurement
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Cole Instrument
Communication Meas. Lab.
Daven Co.
Electronic Dev. Lab.
Electro-Mec Lab.
Electro Products Lab.
Electro-Tech. Equip.
Eppley Laboratory
Feiler Engineering
General Elec. Co.
General Radio Co.
Gray Instrument
Industrial Control
Industrial Inst. Inc.
Leeds & Northrup Co.
Loudon Insts.
Roller-Smith Co.
Rubicon Co.
Shallcross Mfg. Co.
Sticht Co.
Tagliabue Div.
Thwing-Albert Inst. Co.
Welch Mfg. Co.
Winslow Co.

B.T.U. INDICATORS
Central Scientific Co.
Cutler-Hammer Inc.
Hagan Corp.
Precision Scientific

BURETTES
Ace Glass Inc.
Burrell Tech. Supply
Central Scientific Co.
Electronics Products
Fish-Schurman Co.
Fisher Scientific Co.
G. M. Mfg. Co.
Griebel Co.
Hays Corp.
Kahl Scientific Inst.
Kimble Glass Co.
Kontes Glass Co.
Macalaster Bicknell Co.
Machlett & Son
Microchemical Service
Palo-Myers, Inc.
Podbielniak, Inc.
Rascher & Betzold
Robertson & Co., J. H.
Sargent & Co.
Scientific Glass App. Co.
Scientific Instr. Co.
Specialty Glass Co.
Welch Scientific

CABIN PRESSURE CONTROLS (Aeroplane)
AiResearch Div.
Eclipse-Pioneer Div.
Kollsman Instr. Div.
Lear, Inc.
Minneapolis-Honeywell
Robinette Co.
Schwien Engineering

CABINETS, Test (See Chambers, Test)

CABLE TESTERS (See Testers, Cable)

CALIBRATING EQUIPMENT for Electrical Instruments & Meters
Amer. Time Products
Associated Research, Inc.
Beck Bros.
Browning Labs.
Calidyne Co.
Cambridge Inst. Co.
Clippard Inst. Lab.
Cole Instrument
Commercial Research
Daven Co.
Eastern Specialty Co.
Electrical Facilities, Inc.
Electro-Tech. Equip
Electronic Associates
Electronic Dev. Lab.
Feiler Engineering
Ferranti Electric, Inc.
General Electric Co.
Gray Instrument Co.
Hathaway Instrument Co.
Heiland Research
Hewlett-Packard
Hickok Elec. Inst.
Industrial Electronics
Lavoie Laboratories
Leeds & Northrup Co.
Lewis Engineering
(Continued)
Marion Electrical Inst.
M. B. Mfg. Co.
Measurements Corp.
Nankervis Co., G. L.
National Tech. Labs.
Potter Instrument
Premier Crystal Labs.
Radio Frequency Labs.
Rawson Elec. Inst. Co.
RCA
Roller-Smith Co.
Rowe Engineering
Rubicon Co.
Rutherford Electronics
Sangamo Electric
Scott, Inc., Hermon
Sensitive Research Inst.
Shallcross Mfg. Co.
Sorenson & Co.
Sperry Gyroscope Co.
Standard Electric Time
Standard Products Inc.
Televiso Co.
Thwing-Albert Instrument
Walkirt Co.
Western Electro-Mech.
Weston Electrical Inst.

CALIBRATING EQUIPMENT for Testing Machines
American Meas. Inst.
Amer. Time Products
Baldwin-Lima-Hamilton
Cady & Co., E. J.
Commercial Research
Dillon & Co., Inc., W. C.
General Electric Co.
Hathaway Instrument Co.
Instruments Labs.
M. B. Mfg. Co.
Olsen Testing Machine
Pittsburgh Instrument
Riehle Testing Machine
Standard Products Inc.
Steel City Testing Mach.
Thwing-Albert Instrument

CALIPER RULES
American Meas. Inst.
Brown & Sharpe
DoAll Co.
Lufkin Rule Co.
Millers Falls Co.
Starrett Co., L. S.
Weber Co.
Welch Scientific
Zeiss. Inc., Carl

CALIPERS, Indicating
Alina Corp.
American Meas. Insts.
Ames Co., B. C.
Cady & Co., E. J.
DoAll Co.
Federal Products Corp.
Indicating Calipers Co.
Magnetic Gauge Co.
Sheffield Corp.
Starrett Co.

CALIPERS, Inside & Outside
American Meas. Inst.
Brown & Sharpe
DoAll Co.
Eitzen Co.
Farrell-Birmingham (Large for Rolls)
Federal Products Corp.
Glogau & Co.
Indicating Calipers Co.
Jansson Gage Co.
Lufkin Rule Co.
Maveg Machine Sales
Millers Falls Co.
Park Sales
Scherr Co., Inc.
Sheffield Corp.
Starrett Co.
Summers Gyroscope
Welch Mfg. Co.
Zeiss, Inc., Carl

CALIPERS, Square
DoAll Co.
Lufkin Rule Co.
Starrett Co.

CALIPERS, Vernier
Alina Corp.
American Meas. Insts.
Brown & Sharpe
Park Sales Co.
Starrett, L. S.

CALORIMETERS, Adiabatic
Bowen & Co.
Central Scientific
Emerson Apparatus Co.
Ever Ready Thermometer
Parr Instrument Co.

CALORIMETERS, Coal & Fuel
Central Scientific Co.
Emerson Apparatus Co.
Ever Ready Thermometer
Fisher Scientific
Parr Instrument Co.
Precision Therm
Welch Mfg. Co.
Wilkens-Anderson Co.

CALORIMETERS, Gas
American Meter Co.
Central Scientific Co.
Connelly, Inc.
Cutler-Hammer, Inc.
Ever Ready Thermometer
Hays Corp.
Precision Scientific Co.
Precision Thermometer
Refinery Supply Co.
Wilkens-Anderson Co.

CALORIMETERS, Oxygen Bomb
Central Scientific
Emerson Apparatus
Ever Ready Thermometer
Fisher Scientific
Parr Instrument Co.
Refinery Supply Co.

CALORIMETERS, Peroxide Bomb
Ever Ready Thermometer
Fisher Scientific
Parr Instrument Co.
Central Scientific

CALORIMETERS, Steam
Ellison Draft Gage Co.
Ever Ready Thermometer
Welch Scientific
Wilkens-Anderson Co.

CAMERAS, Aerial
Ahrams Instrument
Fairchild Camera & Inst.
Specialties Inc.
Vectron, Inc.

CAMERAS, Microfilm
Abrams Instrument
Bell & Howell
Bolsey Corp.
Burke & James
Eastman Kodak Co.
Graflex Corp.
Microstat Corp.

CAMERAS, Oscillosope Recording
Berkshire Laboratories
Century Geophysical
Electro-Medical Lab.
Fairchild Camera & Inst.
Flight Research Engr.
General Radio
Midwestern Geophysical
Photographic Products
Rutishauser Corp.
Southwestern Ind. Elec.

CAMERAS, SCIENTIFIC
Abrams Instrument
Baird Associates
Bausch & Lomb Opt.
Beckman & Whitley
Burke & James
Cambridge Inst. Co.
Century Geophysical
Coleman Inst. & Mfg.
De Vry Corp.
DuMont Labs.
Eastman Kodak Co.
Electro-Medical Lab.
Fecker, Inc.
Flett Lab.
Flight Research Eng.
General Radio Co.
Graflex Corp.
Heiland Research
Jacobs Instruments
Jarrell-Ash Co.
Leitz, Inc.
Mico Instrument Co.
Perkin-Elmer Corp.
Process & Instruments
Rutishauser Corp.
Stoetting Co., C. J.
Warrick, Frederick
Zeiss, Inc., Carl

CAMERAS, SCIENTIFIC Back Reflection
Abrams Instrument
Bolsey Corp.
Farrand Optical
General Elec. X-Ray Dept.
Hayes Scientific App.
Leitz, Inc.
North Amer. Phillips
Picker X-Ray

CAMERAS, SCIENTIFIC Diffraction (See X-Ray Cameras, Diffraction)

CAMERAS, SCIENTIFIC Motion Picture
Abrams Instrument
Bell & Howell
Bolsey Corp.
Burke & James
De Vry Corp.
Eastern Science Co.
Eastman Kodak Co.
Flight Research Eng.
General Radio Co.
Geophysical Inst. Co.
Jacobs Instruments
Process & Instruments
Maurer, Inc.

CAMERAS, SCIENTIFIC, Photo Micro (See Microscopes, Metallographic)

CAMERAS, SCIENTIFIC, Motion Pictures, High Speed
Bell & Howell
Burke & James
General Radio Co.

CAMERAS, Television
Du Mont Labs., Inc.
General Electric
Jacobs Instruments
Perkin-Elmer Corp.
RCA Div.
Television Equipment

CAPACITANCE METERS
Aerovox Corp.
Biddle Co., Jas. G.
Boonton Radio
Cambridge Inst. Co.
Clough-Brengle Co.
Cole Instruments
Electronic Dev. Lab.
Feiler Engineering
Fielden Instrument
General Elec. Co.
General Radio Co.
Jackson Electrical Inst.
Kalbfell Labs. Inc.
Leeds & Northrup Co.
MacLeod & Hanopol
Panoramic Radio Co.
Premier Crystal Labs.
Radio City Products
Reiner Electronics
Rubicon Co.
Sickles Co.
Solar Mfg. Corp.
Sprague Electric Co.
Triplett Elec. Inst.
Wilson & Co.

Standard CABINET COMPANY

TEST CHAMBERS
High and Low Temperatures Controlled Humidity

+ 200°F. to − 150°F.
20% to 95% R.H.
1 cu. ft. to 75 cu. ft. cabinets
Walk-in Rooms
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Electronic or pneumatic recording
or indicating control systems

CUSTOM CHAMBERS
built to specifications.
years of satisfactory service!

Standard Cabinet Co.
52 Washington Avenue
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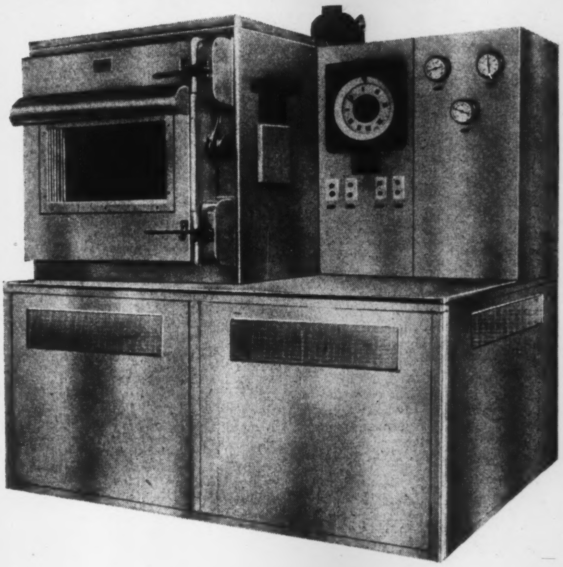

CAPACITORS, Air
Cambridge Inst. Co.
General Electric Co.
General Radio Co.
Johnson Co., E. F.
Leeds & Northrup Co.
Millen Mfg. Co.
North Amer. Philips

CAPACITORS, Electrolytic
Aerovox Corp.
American Condenser
Chicago Condenser
Cornell Dubilier
General Elec. Co.
Industrial Condenser
Magnavox Co.
Mallory & Co.
National Co.
Sangamo Electric
Solar Mfg. Corp.
Sprague Electric Co.
Tobe Deutschmann Corp.
Walker-Jamieson, Inc.
Westinghouse Elec.

CAPACITORS, Mica
Aerovox Corp.
Cambridge Inst. Co.
Cornell Dubilier
Centralab Div.
Crystal Research Labs.
General Elec. Co.
General Radio Co.
Industrial Inst., Inc.
Kellogg Switchboard
Leeds & Northrup Co.
Mallory & Co.
Measurements Corp.
National Co.
RCA
Rubicon Co.
Sangamo Electric Co.
Sickles Co.
Solar Mfg. Corp.
Sprague Electric Co.
United Condenser
Winslow Co.

CAPACITORS, Paper
American Condenser
Aerovox Corp.
Automatic Elec. Chicago
Chicago Condenser
Condenser Products
Cornell Dubilier
Electrical Utilities
Fast & Co., John E.
General Elec. Co.
General Radio Co.
Industrial Condenser
Kellogg Switchboard
Mallory & Co.
National Co.
Potter Co.
Sangamo Electrical Co.
Solar Mfg. Corp.
Sprague Electric Co.
Tobe Deutschmann Corp.

CAPACITORS, Precision
Aerovox Corp.
Brown Electro-Measurement
Cardwell Mfg. Co.
Centralab Div.
Condenser Products
Cornell Dubilier
Crystal Research Labs.
Fast & Co., John E.
General Elec. Co.
General Radio Co.
Gulton Mfg. Co.
Industrial Condenser
Leeds & Northrup Co.
MacLeod & Hanopol
Mallory & Co.
Millen Mfg. Co.
National Co.
Potter Co.
Sprague Electric Co.
Winslow Co.

CAPACITORS, Variable
Bud Radio, Inc.
Cambridge Inst. Co.
Centralab Div.
Clarke Inst. Corp.
Clippard Instrument
Crystal Research Labs.
Dittmore & Freimuth
Eitel-McCullough, Inc.
Engineering Research Ass.
General Elec. Co.
General Radio Co.
Harvey Radio Labs.
Johnson Co., E. F.
Kellogg Switchboard
Leeds & Northrup Co.
Measurements Corp.
Millen Mfg. Co.
National Co.
Oak Mfg. Co.
Rauland Corp.
Rubicon Co.
United Condenser

CAPACITY METERS
Aerovox Corp.
Bernard, H. J.
Bradshaw Instruments
Clough-Brengle Co.
Cole Instruments
Cornell Dubilier
General Elec. Co.
General Radio Co.
Hickok Elec. Inst. Co.
Industrial Inst. Co.
Kalbfell Labs., Inc.
Leeds & Northrup Co.
MacLeod & Hanopol
Premier Crystal Labs.
Radio City Products Co.
Rubicon Co.
Solar Mfg. Corp.
Sprague Electric Co.
Triplett Elec. Inst.
Weston Elec. Inst. Corp.
Yellow Springs Inst.

CARBON DIOXIDE METERS (See Gas Analyzers, Carbon Dioxide)

CARBON MONOXIDE METERS (See Gas Analyzers. Carbon Monoxide)

CARBON PILES (See Resistors, Carbon Compression)

CATHETOMETERS
Cambridge Inst. Co.
Central Scientific Co.
Dietert Co.
Eberbach & Son
Ferner Co.
Gaetner Scientific Corp.
Henson Co., Fred C.
Jarrell-Ash Co.
Mico Instrument Co.
Welch Scientific

CATHODE RAY TUBES (See Oscillographs, Cathode Ray)

CELLS, Concentration
Fish-Schurman Corp.
Leeds & Northrup Co.
Zeiss, Inc.

CELLS, Conductivity, Electrical
Allied Controls Co.
American Inst. Co.
Cambridge Inst. Co.
Central Scientific Co.
Coleman Electric Co.
Engelhard, Charles
Fisher Scientific Co.
Fredericks Co., George
Gray Instrument Co.
H-B Instrument
Industrial Instruments
Instrument Lab., Inc.
Klett Mfg. Co.
Leeds & Northrup Co.
Minnesota Electronics
Phoenix Prec. Inst.
Revere Co.
Sargent & Co.
Scientific Glass App.

CELLS, Conductivity. Thermal
Burrell Tech. Sup.
Cambridge Inst. Co.
Central Scientific Co.
Engelhard, Chas.
Fredericks Co., George
Gow-Mac Instrument Co.
Leeds & Northrup Co.
Victroy Engr.

CELLS, Kerr
Engelhard, Charles
General Physical Lab.
Precise Measurements Co.

ACCURACY OF TEMPERATURE CONTROL DETERMINES ITS QUALITY

ACCURATE control of temperature or pH is vital to modern heat treating or chemical processing, because only in this way can uniform quality be obtained under mass production conditions.

Potentiometers have made such control possible, and "the heart" of these instruments in most cases, for over 25 years, has been the Eplab Standard Cell. This cell is a "yardstick" for the translation of voltage to temperature. The first commercial cell of its type, constant research has made it "as standard as sterling".

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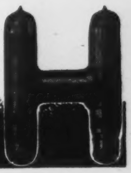
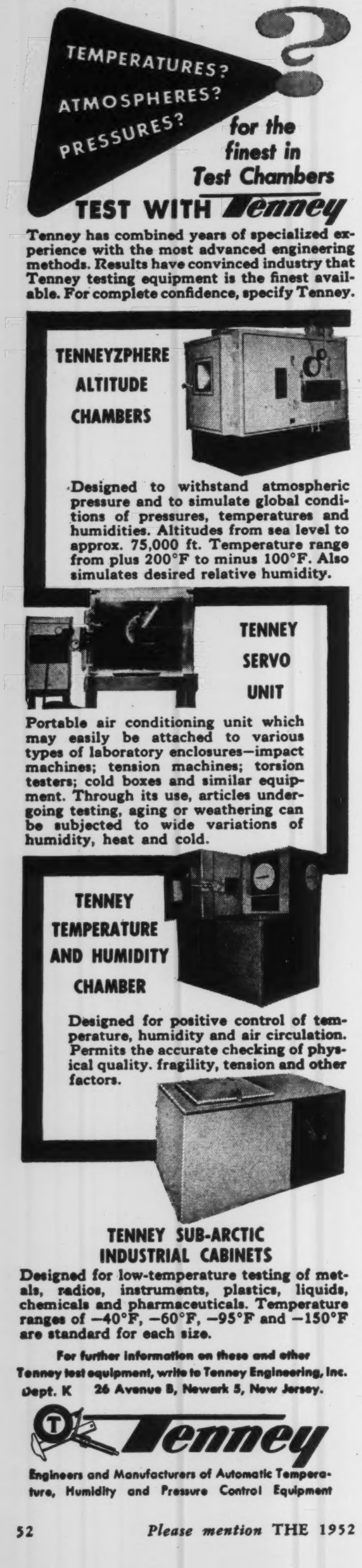
THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS • NEWPORT, R. I., U. S. A.

EPLAB Standard Cells For Potentiometric Instruments As Standard as Sterling





TEMPERATURES?
ATMOSPHERES?
PRESSURES?
for the finest in Test Chambers
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Tenney has combined years of specialized experience with the most advanced engineering methods. Results have convinced industry that Tenney testing equipment is the finest available. For complete confidence, specify Tenney.

TENNEYZPHERE ALTITUDE CHAMBERS

Designed to withstand atmospheric pressure and to simulate global conditions of pressures, temperatures and humidities. Altitudes from sea level to approx. 75,000 ft. Temperature range from plus 200°F to minus 100°F. Also simulates desired relative humidity.

TENNEY SERVO UNIT

Portable air conditioning unit which may easily be attached to various types of laboratory enclosures—impact machines; tension machines; torsion testers; cold boxes and similar equipment. Through its use, articles undergoing testing, aging or weathering can be subjected to wide variations of humidity, heat and cold.

TENNEY TEMPERATURE AND HUMIDITY CHAMBER

Designed for positive control of temperature, humidity and air circulation. Permits the accurate checking of physical quality. fragility, tension and other factors.

TENNEY SUB-ARCTIC INDUSTRIAL CABINETS

Designed for low-temperature testing of metals, radios, instruments, plastics, liquids, chemicals and pharmaceuticals. Temperature ranges of −40°F, −60°F, −95°F and −150°F are standard for each size.

For further information on these and other Tenney test equipment, write to Tenney Engineering, Inc.
Dept. K 26 Avenue B, Newark 5, New Jersey.

Tenney
Engineers and Manufacturers of Automatic Temperature, Humidity and Pressure Control Equipment

CELLS, Photoelectric
Bradley Labs.
Continental Elec. Co.
Dearborn Scientific
De Jur-Amsco Corp.
Eby, Inc.
Electronic Prod. Co.
Federal Telephone
Fredericks, George
General Elec. Co.
General Scientific Corp.
Hickok Elec. Inst. Co.
Instruments Dev. Labs.
International Rectifier
Leitz, Inc.
Luminite Elec. Co.
Photovolt Corp.
Phoenix Prec. Inst.
Porter, George K.
Potter Instrument
Precise Measurements
Rauland Corp.
RCA
Vacutron, Inc.
Vickers Electric
Westinghouse Electric Co.
Weston Elec. Inst. Corp.
Worner Electronics

CELLS, Standard
Cambridge Inst. Co.
Central Scientific
Eppley Lab.
Gray Instrument
Leeds & Northrup Co.
Phoenix Prec. Inst.
Rubicon Co.
Tagliabue Div.
Thwing-Albert
Weston Elec. Inst. Corp.

CEMENT APPARATUS (See Testers & Testing Machines, Cement)

CEMENTING GAGES (See Gages, Cementing)

CEMENT MOLDS
American Inst. Co.
Bowen & Co.
Central Scientific Co.
Fisher Scientific Co.
Humboldt Mfg. Co.
Olsen Testing Machine
Precision Scientific Co.
Standard Concrete App.

CEMENT NEEDLE APPARATUS
American Inst. Co.
Central Scientific
Fisher Scientific Co.
General Cement Mfg.
Humboldt Mfg. Co.
Olsen Testing Machine
Precision Scientific

CENTRIFUGES
Central Scientific
Clay Adams Co.
Fisher Scientific Co.
Glass Engg. Labs.
Goetze Niemer Co.
Haines Designed Prod.
International Equipment
Microchemical Service
Phipps & Bird
Podbielniak, Inc.
Precision Scientific Co.
Sargent & Co.
Specialized Insts.
Thomas Co., Arthur H.
Technical Products Co.
Williams Apparatus Co.

CENTRIFUGES, Paper Testing
International Equipment
Williams Apparatus Co.

CENTRIFUGES, Oil Testing
Boekel & Co.
Braun Corp.
Central Scientific Co.
Eclipse Pioneer Div.
International Equip.
Moeller Inst. Co.
Podbielniak, Inc.
Precision Scientific Co.
Refinery Supply
Tagliabue Div.
Thomas Co., Arthur H.
Westinghouse Elec. & Mfg.

CENTRIFUGES, Ultra-Speed
Fisher Scientific Co.
Haines Designed Prod.
Precision Scientific

CHAINS, SURVEYOR'S (See Surveying Instruments)

CHAMBERS, TEST & CALIBRATION
American Instrument Co.
Anetsberger Bros.
Atlas Electric Devices
Bowser, Inc.
Distillation Products
Electric Hotpack Co.
Food Technology, Inc.
Gadgets, Inc.
Ideal Lab. Tool
Meriam Inst. Co.
National Research
Premier Crystal Labs.
Refrigeration Sys.
Revco, Inc.
Standard Cabinet Co.
Standard Products Inc.
Sub-Zero Prod. Div.
Tenney Engineering
Thwing-Albert Inst. Co.
York Ice Machinery Corp.

CHART-GAGES for Optical Comparators
Engineers' Specialties Div.

CHECKERS, RADIO TUBE (See Analyzers, Radio Set)

CHEMICAL FEEDERS, Automatic pH Control
Askania Regulator Co.
Bristol Co.
Electronic Prod. Co.
International Filter Co.
Lapp Insulator
Leeds & Northrup Co.
Milton Roy Co.
National Tech. Labs.
Neptune Pump
Omega Machine
Permutit Co.
Proportioneers, Inc.
Tagliabue Div.
Wallace & Tiernan

CHEMICAL FEEDERS, Dry & Liquid
Askania Regulator Co.
Builders-Providence
Fischer & Porter
Gump Co., B. F.
Jeffrey Mfg. Co.
Arthur D. Little
Milton Roy Co.
Neptune Pump
Omega Machine Co.
Permutit Co.
Phipps & Bird
Proportioneers, Inc.
Richardson Scale Co.
Wallace & Tiernan Prod.

CHEMICAL PORCELAIN (See Porcelain, Laboratory)

CHLORINE CONTROL APPARATUS (See Controllers, Automatic, Chlorine)

CHLORINE TESTING APPARATUS (See Testers, Chlorine)

CHOKES
Airdesign, Inc.
Amplifier Co.
Annis Co.
Audio Development
Better Coils Inc.
Bud Radio, Inc.
Chicago Transformer
Clough-Brengle Co.
Control Corp.
Fast & Co., John E.
Freed Transformer
Halldarson Co.
Harvey Radio Labs.
Instrument Resistors
Madison Elec. Prod. Div.
Mallory & Co.
Merit Transformer
National Co.
Ohmite Mfg. Co.
Radex Corp.
Raytheon Mfg. Co.
Sickles Co.
Sorensen & Co.
Standard Transformer
Superior Electric Co.
Sylvania Elec. Prod.
Thermador Elec. Mfg.
Thordarson Elec. Co.
Trenton Transformer
United Transformer Corp.

CHOPPERS, D.C.—A.C.
Applied Science Corp.
Liston-Folb
Millivac Instrument
Stevens-Arnold

CHRONOGRAPHS
American Inst. Co.
American Time Prods.
Aristo Import Co.
Cambridge Inst. Co.
Clebar Watch Co.
Ducommun Co.
Electro-Medical Lab.
Esterline-Angus Co.
Fecker, Inc.
Ferner Co.
Gaertner Scientific Corp.
General Elec. Co.
Gorrell & Gorrell
Hamilton Watch Co.
Hathaway Inst. Co.
Huggins Lab.
Jaeger Watch Co.
Jardur Import Co.
Leeds & Northrup
Metron Instrument
Nelson & Street
Pierce Watch Co.
Potter Instrument
Precision Thermometer
Sticht Co.

CHRONOMETERS
Bliss & Co.
Ducommum Co.
Elgin National Watch
Gaertner Scientific
Hamilton Watch
Jardur Import Co.
Negus, T. S. & J. D.
Potter Instrument
Standard Electric Time
Stoelting Co., C. H.
Waltham Watch Co.

CHRONOSCOPE
Amer. Chronascope
Berkeley Scientific
Potter Instrument
Process & Instruments
Rawson Elec. Inst.
Stoelting Co., C. H.

CIRCUIT BREAKER ANALYZERS
Cincinnati Clock
Cole Instruments
Esterline-Angus

CIRCUITS, Printed Electric
Allied Engraving & Stamp.
Cole Instrument
Engr. Research & Dev.
Gulton Mfg. Co.
Gurley, W & L. E.

CLASSIFIERS, Particle Size, Air
Federal Classifier
Fisher Scientific
Robinette Co.

CLEANING MACHINES, Instrument (See Instrument Cleaning Machines)

CLINOGRAPHS, Bore Hole
Geophysical Inst. Co.
Sperry-Sun Well Survey'g

CLINOMETERS (for determining ceiling height of clouds)
Alden Products
Alfax Paper & Eng.
Geier & Bluhm, Inc.
Leeds & Northrup
Stoelting Co., C. H.
White Co., Inc., David

CLINOMETERS, Angular Measuring
Engis Equipment
Ferner Co.
Jarrel-Ash Co.
Negus, T. S. & J. D.
Precision Thermometer
Warren-Knight Co.

CLINOMETERS, Geologists
Stratex Instrument Co.

CLINOMETERS, Ship
Eastern Specialty Co.
Hand & Sons
Instruments Corp.
Manning, Maxwell, Moore
Marine Compass
Moeller Inst. Co.
Negus, T. S. & J. D.
Northwest Instrument
Precision Thermometer
Serdex, Inc.

CLOCKS, Master
Alina Corp.
Cincinnati Time Rec. Co.
Elgin National Watch
Gaertner Scientific Corp.
General Electric Co.
International Bus. Mach.
Jacobs Instruments
Landis & Gyr, Inc.
National Time & Signal
Neomatic
Simplex Time Rec.
Standard Elec. Time
Stromberg Time Corp.
Telechron, Inc.
Thomas Clock Co.
Wallace & Tiernan
Waltham Watch

CLOCKS, Minute Impulse & Synchronous
Alina Corp.
Betts & Betts
Chelsea Clock Co.
Cincinnati Clock
Cincinnati Time Rec. Co.
Cramer & Co., Inc.
Elec. Tachometer Corp.
Electyme Motor Products
General Elec. Co.
Hansen Co.
Haydon Co.
International Bus. Mach.
Landis & Gyr.
Lumenite Electronic
National Time & Signal
Neomatic
Phipps & Bird
Simplex Time Rec.
Standard Elec. Time Co.
Stoelting Co.
Stromberg Time Corp.
Telechron, Inc.
Thomas Clock Co.
Tork Clock
Waltham Watch
Westinghouse Elec.

CLOCKS, Primary
Alina Corp.
Chelsea Clock Co.
Cincinnati Time Rec. Co.
Eclipse-Pioneer Div.
Elgin National Watch
General Elec. Co.
General Radio Co.
International Bus. Mach.
Landis & Gyr.
National Time & Signal
Roth Bros. Chronometer
Standard Elec. Time
Stromberg Time Corp.
Telechron, Inc.
Thomas Clock Co.
Wallace & Tiernan
Waltham Watch

CLOCKS, Secondary
Alina Corp.
Automatic Elec. Chicago
Cincinnati Time Rec. Co.
Elgin National Watch
General Elec. Co.
Howard Clock Products
International Bus. Mach.
Landis & Gyr
National Time & Signal
Simplex Time Rec.
Standard Elec. Time
Stromberg Time Corp.
Telechron, Inc.
Thomas Clock Co.
Waltham Watch

CLOCKS, Standard
Alina Corp.
Aristo Import Co.
Chelsea Clock Co.
Cincinnati Clock & Inst.
Cincinnati Time Rec.
Foxboro Co.
Gaertner Scientific Corp.
Hansen Co.
Jaeger Watch Co.
Kollsman Inst. Co.
Lux Clock Mfg. Co.
(Continued)
National Time & Signal
Negus, T.S. & J.D.
Seth Thomas Clock
Standard Elec. Time
Stromberg Time Corp.
Telechron, Inc.
Tork Clock Co.
Waltham Watch

CLOCKS, Stop
Boeckeler Instruments
Central Scientific Co.
Clebar Watch Co.
Dimo-Gray Co.
Elgin Nat. Watch
Fish-Schurman Co.
Glogau & Co.
Jaeger Watch Co.
Jardur Import Co.
National Time & Signal
Negus, T.S. & J.D.
Precision Scientific Co.
Standard Elec. Time
Sticht Co.
Stoelting Co., C. H.
Tagliabue Div.
Thompson Clock Co.
Telechron, Inc.
Waltham Watch

CLOUD & POUR TEST APPARATUS
Ace Glass Inc.
American Inst. Co.
Bowser Refrig. Inc.
Central Scientific Co.
Corning Glass Works
Fisher Scientific Co.
Humboldt Mfg. Co.
Koehler Inst. Co.
Kontes Glass Co.
Moeller Inst. Co.
Precision Scientific Co.
Refinery Supply Co.
Refrigeration Sys.
Ruehfel Co.
Scientific Inst. Co.
Scientific Glass App.
Tagliabue Div.
Tenney Engineering

COAL METERS
Bailey Meter Co.

COIL TESTING EQUIPMENTS (See Testers, Coil)

COLLIMATORS, Vertical
Berger & Sons
Dusenbery Co.
Engis Equipment
Fecker, J. W.
Gaertner Scientific
Geophysical Inst. Co.
Jacobs Instruments
Link Aviation Devices
Perkin-Elmer Corp.
Palos Optical Co.
Unertl Optical Co.
White Co. Inc.

COLOR ANALYZERS, Photoelectric
Ansco
Applied Physics Corp.
Bausch & Lomb Optical
Berkshire Laboratories
Central Scientific Co.
Dearborn Scientific
De-Tec-Tronic Labs.
Ess Inst. Co.
Farrand Optical
Fish-Schurman Corp.
Fisher Scientific Co.
Gaertner Scientific Corp.
Gardner Laboratory
General Electric Co.
General Radio Co.
Huggins Labs.
Instrument Development
Jacobs Instrument
Jarrell-Ash Co.
Klett Mfg. Co.
Librascope
Madison Elec. Prod.
National Tech. Labs.
Pfaltz & Bauer, Inc.
Photoswitch, Inc.
Photovolt Corp.
Precise Measurements
Rawson Elec. Inst. Co.
Rubicon Co.
Westinghouse Elec.
Willmotte, Inc.

COLOR COMPARATORS, Photoelectric (See Color Analyzers, Photoelectric

COLOR COMPARATORS, Visual
Baird Associates
Bausch & Lomb Optical
Central Scientific Co.
Electronic Engineers
Fisher Scientific Co.
Gaertner Scientific Corp.
Gardner Laboratory
Hellige, Inc.
Instrument Dev. Labs.
Jarrell-Ash Co.
Klett Mfg. Co.
Koehler Instrument
LaMotte Chemical Prod.
Macbeth Corp.
Menlo Research Lab.
Munsell Color Co.
Precise Measurements
Phipps & Bird
Phoenix Precision Inst.
Precise Measurements Co.
Rascher & Betzold
Tagliabue Div.
Taylor & Co., W. A.
Westinghouse Elec.
Zeiss, Inc., Carl

COLOR GRADERS (See Color Analyzers, Photoelectric)

COLOR MATCHING OUTFITS (See Color Comparators, Visual)

COLORIMETER TUBES (See Colorimeters, Visual)

COLORIMETERS, Photoelectric
American Inst. Co.
Associated Research
Berkshire Laboratories
Central Scientific Co.
Clay-Adams Co.
Coleman Instruments
Dearborn Scientific
De-Tec-Tronic Labs.
Farrand Optical
Fish-Schurman Corp.
Fisher Scientific
Gardner Laboratory
General Elec. Co.
Hellige, Inc.
Huggins Labs.
Instrument Dev. Labs.
Jarrell-Ash Co.
Klett Mfg. Co.
Leitz, Inc.
National Tech Labs.
Phoenix Prec. Inst.
Photovolt Corp.
Photron Instrument
Process Instruments
Rubicon Co.
Scientific Glass App.
Technical Products
Will Corporation

COLORIMETERS, Visual
American Inst. Co.
American Optical
Bausch & Lomb Optical
Central Scientific Co.
Coleman Electric Co.
Fischer & Porter
Fish-Schurman Corp.
Fisher Scientific Co.
Gardner Laboratory
Hellige, Inc.
Jarrell-Ash Co.
Klett Mfg. Co.
Koehler Instrument
Munsell Color Co.
Precise Measurements
Precision Scientific
Rascher & Betzold
Tagliabue Div.
Technical Products
Zeiss, Inc., Carl

COMBUSTION, Indicators and Recorders (See Gas Analyzers, Boiler Meters, etc.)

COMBUSTION CONTROL EQUIPMENT (See Controllers, Automatic-Combustion)

COMBUSTION FURNACE, Laboratory, High Temperatures, see Furnace, Laboratory

COMMUNICATION MEASURING INSTRUMENTS
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Ballantine Labs.
Boonton Radio Corp.
Brush Development Co.
Burlington Inst. Co.
Clarke Inst. Corp.
Clough Brengle Co.
Cole Instruments
Communication Meas. Lab.
Dale Instruments
Daven Co.
Elec. Indicator Co.
Electric Des. & Mfg.
Electronic Associates
Electronic Dev. Lab.
Esterline-Angus
Federal Telephone
Feiler Engineering
Ferris Inst. Corp.
Freed Transformer
General Electric Co.
General Radio Co.
Harvey Radio Labs.
Hewlett-Packard
Hickok Elec. Inst. Co.
Industrial Inst. Co.
Kay Electric Co.
Kellogg Switchboard
Leeds & Northrup Co.
Measurements Corp.
Millen Mfg. Co.
Precision Apparatus Co.
Premier Crystal Labs.
RCA Div.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Sherron Metalic
Sound Apparatus
Sperry Gyroscope Co.
Stafford Co.
Sylvania Elec. Prod.
Technology Instrument
Thordarson Elec. Mfg.
Trimount Inst. Co.
Triplett Elec. Inst.
Vapor Recovery Systems
West Coast Electronics
Westinghouse Elec.
Weston Elec. Inst. Corp.

COMPARATORS, A. C. Voltage
Cole Instrument
DoALL Co.
Feiler Engineering

COMPARATORS, Electrical Resistance
Associated Research
Borden Engineering
Bowser, Inc.
Cole Instrument
Dice Co., J. W.
Electronic Instrument
Federal Products
Feiler Engineering
General Radio

COMPARATORS, Mechanical
American Meas. Insts.
Arma Corp.
Bryant Chucking
DoAll Co.
Electronic Research Labs.
Farrell-Birmingham
(Gear Tooth)
Federal Prod. Corp.
Ferner Co.
Gaertner Scientific
Graham-Mintel Inst.
Hathaway Inst. Co.
Henson Co., Fred C.
Johnson Gage Co.
Leitz, Inc.
Maveg Mach. Sales
Metron Instrument
Mico Instrument Co.
Nankervis Co., G. L.
Park Sales
Pratt & Whitney
Precision Scientific
Scherr Co., Inc.
Sheffield Corp.
Size Control Co.
Standard Gage
Swedish Gage
Wilder, R. S.

COMPARATORS, Optical
American Meas. Inst.
Bausch & Lomb Optical
Brush Development
Cambridge Inst. Co.
Compar Instrument
DoAll Co.
Electronic Research Labs.
Engineers Specialty Div.
Fecker, Inc.
Ferner Co.
Fish-Schurman Corp.
Gaertner Scientific
Jarrell-Ash Co.
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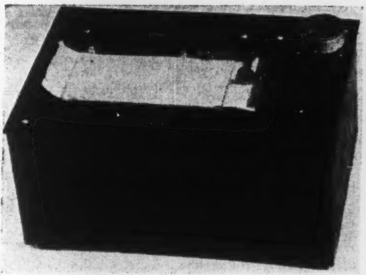
Lab. Specialties
Leitz Inc.
Menlo Research Lab.
Precision Scientific
Ruska Inst. Corp.
Scherr Co., Inc.
Sheffield Corp.
Stocker & Yale
Van Keuren Co.
Zeiss, Inc., Carl

COMPARATORS, Surface Finish Standards
Compar Instrument
General Electric Co.
Link Engineering
Sheffield Corp.
Surface Checking Gage
Swedish Gage Co.



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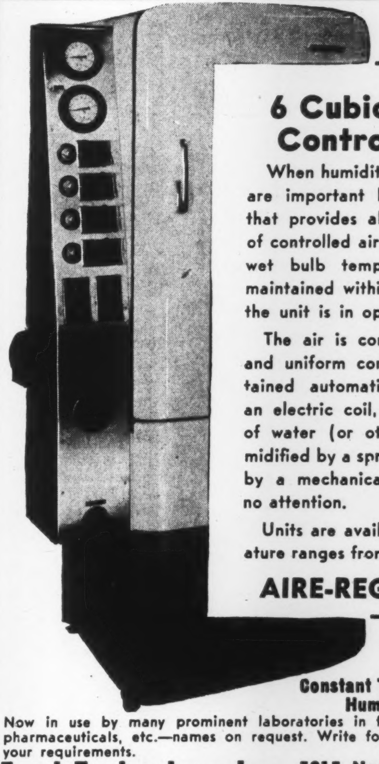

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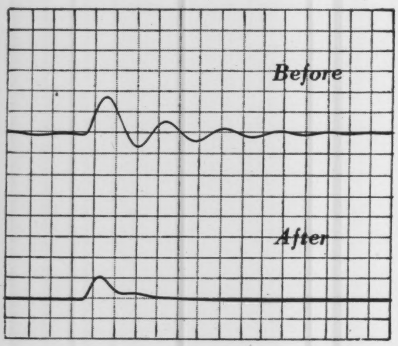

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Ritchie & Son
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Sperry Gyroscope Co.
Summers Gyroscope

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Suverkop Instruments
Taylor Inst. Cos.
White Co., Inc., David

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Suverkop Instruments
Taylor Inst. Cos.
Testrite Instrument Co.
U. S. Gauge Co.
Waltham Watch
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Bendix Marine Products
Bliss & Co.
Bunnell Co., J. H.
Dirigo Compass
Dusenbery Co.
Geophysical Inst. Co.
Hand & Sons
Hull Mfg. Co.
Kuner Co., Max
Marine-Compass Co.
Negus T. S. & J. D.
Northwest Instrument
Ritchie & Son
Sperry Gyroscope Co.
Starr Compass Co.

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Eclipse-Pioneer Div.
Fairchild Camera
Fisher Research Lab.
Hickok Elec. Inst. Co.
Lear. Inc.
Northwest Instrument
RCA Div.
Triumph Mfg. Co.

COMPASSES, Ship (See Compasses, Marine

COMPASSES, Telltale (See Compasses, Marine)

COMPENSATION, Magnetic
Dusenbery Co.
Geophysical Inst. Co.
Hand & Sons
Marine Compass

COMPOUNDS, Cleaning & Rinsing for Instruments (See Instrument Cleaning Machines

COMPRESSORS, Instrument Air
Ingersoll-Rand
Nash Engineering
Powers Regulator Co.

COMPUTERS, Analog, Digital
AiResearch Div.
Askania Regulator
Audio Instrument
Cole Instrument
Electro-Mec. Lab.
Engineering Res. Assoc.
Genisco Inc.
Jacobs Instrument Co.
Laboratory for Electronics
Librascope
Potter Instrument
Radioactive Products
Reed Research
Servo Corp.
Servo Tek Products
Specialties Inc.
Vectron, Inc.
Walkirt Co.

COMPUTER, Simultaneous Equations
Arma Corp.
Consolidated Engineering
Doelcam Instrument
Ford Inst. Co.
General Electric Co.
Hellver Instrument
Krohn-Hite Inst.
Laboratory for Electronics
Librascope
Philbrick Researches
Reeves Instrument

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Philbrick Researches
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Reed Research
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Esterline-Angus Co.
Foxboro Co.
Industrial Insts. Inc.
Leeds & Northrup
Patwin Inst. Div.
Rubicon Co.
Skaneateles Mfg.

CONDENSER, Electric (See Capacitors)

CONDENSER LEAKAGE, Indicators
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Clough-Brengle Co.
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Electronic Dev. Lab.
Feiler Engineering
Fox Valley Inst.
General Elec. Co.
Hickok Elec. Inst. Co.
Industral Inst. Inc.
Jackson Electrical Inst.
Leeds & Northrup Co.
Potter Co.
Radio City Products Co.
Rawson Elec. Inst. Co.
Reiner Electronics
Tobe Deutschmann Corp.
Triplett Elec. Inst.
Triumph Mfg. Co.
Weston Elec. Inst. Co.

CONDENSER LEAKAGE, Recorders
Esterline-Angus Co.
Leeds & Northrup

CONDENSER TESTERS (See Testers, Condenser)

CONDUCTIVITY METERS
American Inst. Co.
Bailey Meter Co.
Biddle Co., James G.
Brown Inst. Div.
Central Scientific Co.
Coleman Instrument
Electronic Prod. Co.
Esterline-Angus Co.
Foxboro Co.
Gray Instrument
Industrial Inst. Inc.
Instrument Lab., Inc.
Leeds & Northrup Co.
Minnesota Electronics
RCA
Reverē Corp.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Sherron Metallic
Thwing-Albert Instrument

CONES, Pyrometric
Accurate Pyrometric Cone
Fish-Schurman Co.
Gordon Co.
Henderson & Co.
Orton Ceramic Found.
Wheelco Insts. Co.

CONES, Slump
American Inst. Co.
Central Scientific Co.
Humboldt Mfg. Co.
Precision Scientific Co.
Riehle Div.

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Aerolite Electronic
Aircraft Marine Products
American Communications
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Audio Development
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Automatic Elec. Chicago
Berkshire Laboratories
Breeze Corp.
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Burke Electric Co.
Burndy Engineering
Cannon Electric
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Clare & Co.
Dittmore & Friemuth
Eastern Specialty Co.
Eby Inc.
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General Elec. Co.
General Radio Co.
Harvey-Wall Electronics
Johnson Co., E. F.
Jones, Howard B., Div.
Kellogg Switchboard
Lewis Engineering
Mallory & Co.
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Millen Mfg. Co.
Pyle National
RCA
Revere Corp.
Richards Co., Inc.
Shallcross Mfg. Co.
Standard Elec. Time
States Co.
Teleoptic Co.
Thermo-Electric Co.
Thwing-Albert Inst. Co.
Winchester Electronics

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American Time Prods.
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Elec. Tachometer Corp.
Gaertner Scientific Corp.
General Elec. Co.
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Leeds & Northrup
Rockwell Engr.
Sorensen & Co.
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Fish-Schurman Corp.
Jarrell-Ash Co.
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Martin Hubbard Corp.
Scherr Co., Inc.
Sheffield Corp.
Stocker & Yale
Wilder, R. S.

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Allied Engraving & Stamp.
Askania Regulator
Automatic Temp. Control
Barnes Co., W. F. & J.
Bristol Co.
Bud Radio, Inc.
Dorothea Mechanisms, Gale
Falstrom Co.
Kirk & Blum Mfg.
Panellit
Richardson Scale Co.
Standard Elec. Time

CONTROL DRIVES (See Servo-Motors)

CONTROLS, AUTOMATIC (See Controllers, Automatic)

CONTROLLERS, AUTOMATIC (See object of Measurement and Control)

"CONTROL" —NOTE—

The following pages deserve close study. Note for example that after numerous "Controllers, Automatic" there are three classes of "Controllers, Manual." Look up also under "Regulators" for many types thus termed by usage. Also "Thermostats" and other commonly-used names of specific-purpose, automatic controllers.

As a rule, Automatic Controllers are "Instrument like" while devices known as Controls (preceded by name of application) are simple, single-purpose devices.

CONTROLLERS, AUTOMATIC, Ammonia (See Ammonia Control Equipment)

CONTROLLERS, AUTOMATIC, Beater (See Controllers, Automatic, Consistency

CONTROLLERS, AUTOMATIC, Bin (See Controllers, Automatic, Granular Material, Level)

CONTROLLERS, AUTOMATIC, Boiler Feed
Ace Instrument
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Campbell Co., J. A.
Climax Div.
Combustion Control Corp.
Fisher & Porter
Fisher Governor
Foster Engg. Co.
Foxboro Co.
General Controls
Hammel-Dahl- Co.
Henszey Co.
Jo-Bell Products
Kieley & Mueller
Leeds & Northrup
Lumenite Electronics
Magnetrol, Inc.
Manning-Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg.
Mercoid Corp.
Mercon Regulator Co.
Minneapolis-Honeywell
Natural Gas Equipment
Northern Equip. Co.
Photoswitch, Inc.
Republic Flow Meters Co.
Ruggles Klingemann
Squires Co., C. E.
Swartwout Co.
Taylor Inst. Cos.
Trimount Inst. Co.
Warrick Co.
Watts Regulator Co.
Wheelco Instruments

CONTROLLERS, AUTOMATIC, Boiler Water Concentration
Campbell Co., J. A.
Fischer & Porter
Foxboro Co.
General Controls
Hammel-Dahl Co.
Henszey Co.
Jo-Bell Products
Leeds & Northrup Co.
Lumenite Electronics
Manning, Maxwell & Moore
Mason-Neilan Reg.
Minneapolis-Honeywell
Photoswitch, Inc.
Powers Regulator
Republic Flow Meters

CONTROLLERS, AUTOMATIC, Bulk Material Level (See Controllers, Automatic, Granular Material Level)

CONTROLLERS, AUTOMATIC, Chlorine
Arca Regulators, Inc.
Askania Regulator Co.
Beckman Instruments
Brooks Rotameter
Builders-Providence
Cash Co.
Fischer & Porter
Foster Engineering
Foxboro Co.
General Controls
Hammel-Dahl Co.
LaMotte Chemical Prod.
Lapp Insulator
Magnetrol, Inc.
Manning, Maxwell & Moore
National Meter Co.
Photoswitch, Inc.
Proportioneers, Inc.
Rasher & Betzold
Republic Flow Meters
Shallcross Controls
Taylor Inst. Co.
Wallace & Tiernan

CONTROLLERS, AUTOMATIC, Combustion
Ace Instrument Co .
Arca Regulators, Inc.
Askania Regulator Co.
Bailey Meter Co.
Beckman, Inc., Arnold O.
Bristol Co.
Brooke Eng. Co.
Burrell Technical
Cambridge Inst. Co.
Cash Co.
Cleveland Fuel Eng.
Combustion Control Corp.
Electronic Prod. Co.
Fischer & Porter
Fisher Governor
Foxboro Co.
Furst Electronics
General Controls
General Power Plant
General Regulator Corp.
Hagan Corp.
Hammel-Dahl Co.
Hays Corp.
Leeds & Northrup Co.
Mason-Neilan Reg. Co.
Mercoid Corp.
Mine Safety Appliances
Minneapolis-Honeywell
National Brass Co.
Natural Gas Equipment
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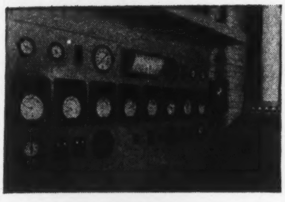
Partlow Corp.
Perfex Corp.



BAILEY METER *Combustion* CONTROL

● Bailey Meter Automatic Combustion Control of boilers results in substantial saving in fuel; increased boiler capacity; reduction of boiler and furnace maintenance; more time for operators to devote to general station maintenance; and improvement in the general character of service.

Bailey Meter Control makes possible the everyday operation of boilers at test efficiencies because it is a complete combustion control system which (1) automatically maintains steam pressure by supplying fuel and air simultaneously to boilers in accordance with changes in steam demand, (2) automatically maintains most economical fuel-air ratio by incorporating the Bailey Boiler Meter as an integral part of the system, (3) automatically maintains the desired furnace draft, and (4) automatically distributes load among boilers so that each unit carries its share.

This sturdy inexpensive air-operated control system has been applied to all sizes and types of boilers ranging from 200 h.p. upward. It is applicable to all fuels and all methods of firing.

For further information consult Sweet's Engineering Catalogs or write for bulletin No. 102.

BAILEY METER COMPANY
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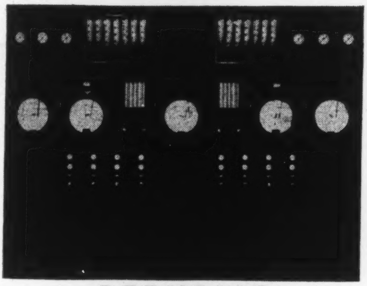
Bailey Meter Company Ltd., Montreal, Canada



REPUBLIC COMBUSTION CONTROL

Republic automatic combustion control is available for all sizes of boilers, all types of fuel firing, all load conditions and any arrangement of draft equipment.

The Republic combustion control (1) automatically maintains constant steam pressure by controlling the heat input to the boilers; (2) automatically maintains highest combustion efficiency by controlling simultaneously the fuel and air input in measured proportions; (3) automatically maintains any desired load division between the boilers; (4) automatically maintains the correct constant draft in each furnace.

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REPUBLIC FLOW METERS CO.
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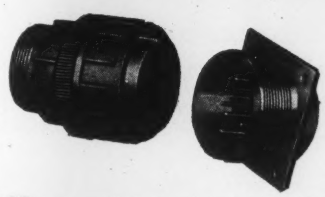
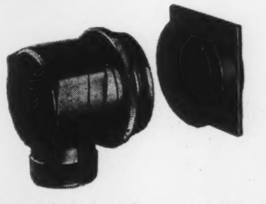
the highest quality and greatest variety for the instrument industry

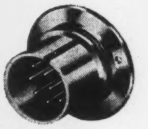


AN Originally dsigned for Army-Navy Specification requirements. Now used widely for instruments. Connects and disconnects by screw action of threaded coupling ring. Made in 2 plug types—3 receptacles with variations and accessories, in 15 shell sizes and more than 200 insert arrangements.

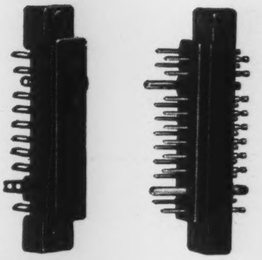


K Light weight, aircraft type connector ideal for many instruments. Connects and disconnects manually. Is held together by Acme thread coupling ring. Made in 7 shell types in 8 different diameters and more than 190 insert arrangements.

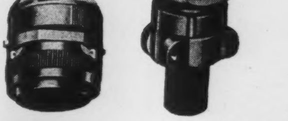
GS Hermetically sealed by use of glass beads fused to shell and contact, both machined from cold rolled steel. Made in 2 shell types—10 diameters and currently having 30 layout arrangements. Additional arrangements are being designed.



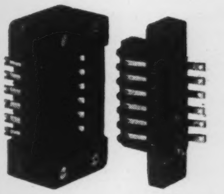
RS Hermetically sealed with special resilient rubber inserts. Specially adapted to aircraft relays and other sealed components. These fittings mate with standard "AN" Connectors having corresponding inserts.



DPM This series used primarily on electronic equipment where a multiple contact, rack and panel connector of extremely small dimensions is required. Both plug and receptacle are rigidly mounted. Connect and disconnect automatically when assemblies, to which they are mounted, are joined or separated. Made in 2 sizes having 2 contact arrangements.



AN-M For the tough jobs. Moisture-proof, vibration-proof and pressurized. Radio shielding is provided and all threaded parts are drilled for safety wiring. Connect and disconnect by screw action of threaded coupling ring. The variety of sizes and layout arrangements is nearly as great as the AN line.



RTC Is a quick disconnect requiring low separation force and having simple mounting requirements for chassis or wall types. Moisture drain holes provided in receptacle section. Plug section provides for lacing down wires after soldering. Made in five sizes.

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For engineering data on any of these Cannon Plugs request free bulletins by type, such as "K", "GS", "RTC", etc. Address your request to Cannon Electric Company, P.O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

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The Protectoglo operates on the "flame rectification" principle . . . the safest and most fool-proof method of flame failure protection. Failure automatically results in complete safety shut-down. Four different flame detector units afford versatility of application.

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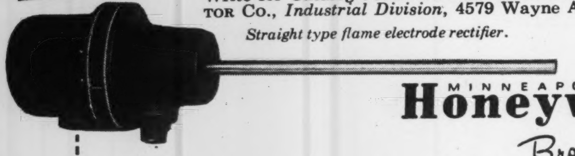

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CONTROLLERS, AUTOMATIC, Cycle

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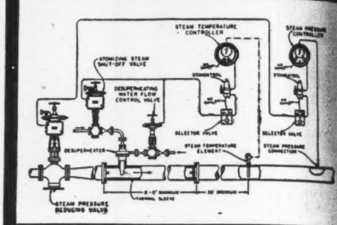
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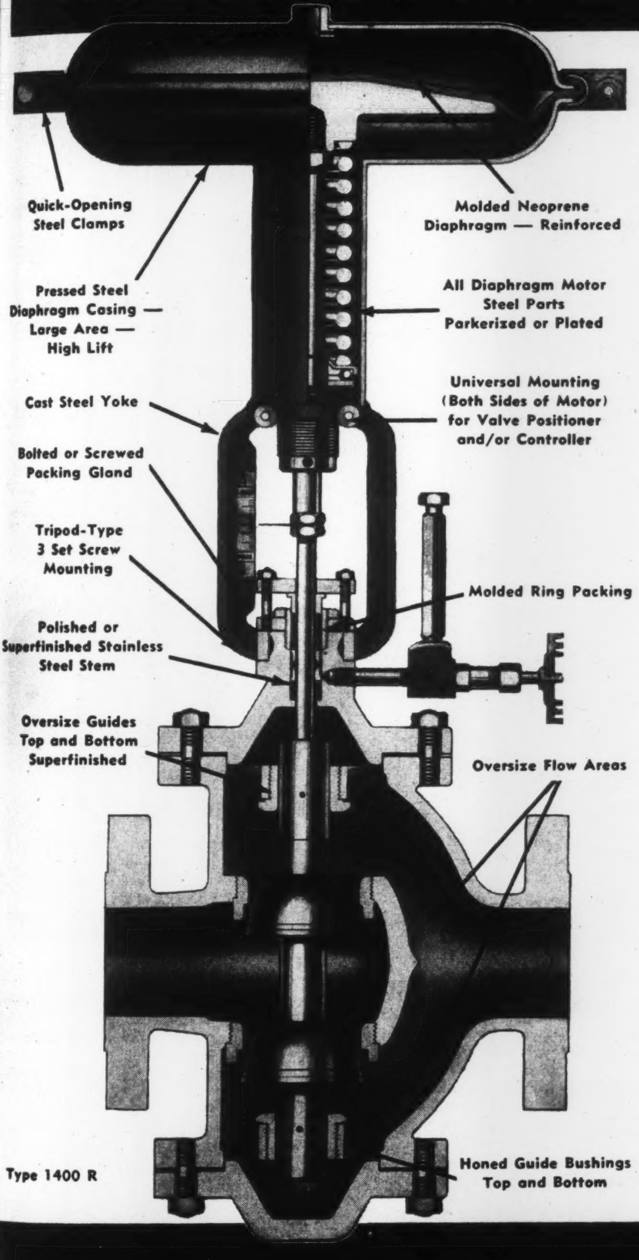
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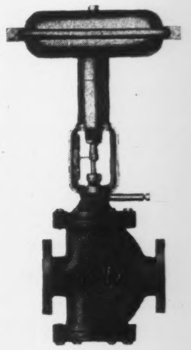
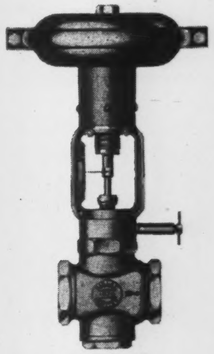


Type 1200



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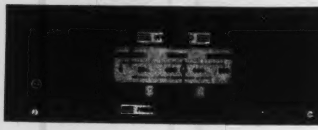

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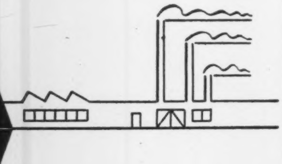

• CONTROLS
• SERVOS
• COMPONENTS

$$\mu_2(d) = \frac{1}{m}\sum n_j(a_j - \bar{a})^2$$

$$\frac{1}{2T}\int_{-T}^{T} f_1(t)\, f_1(t+\tau)\,dt$$

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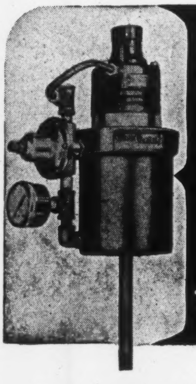

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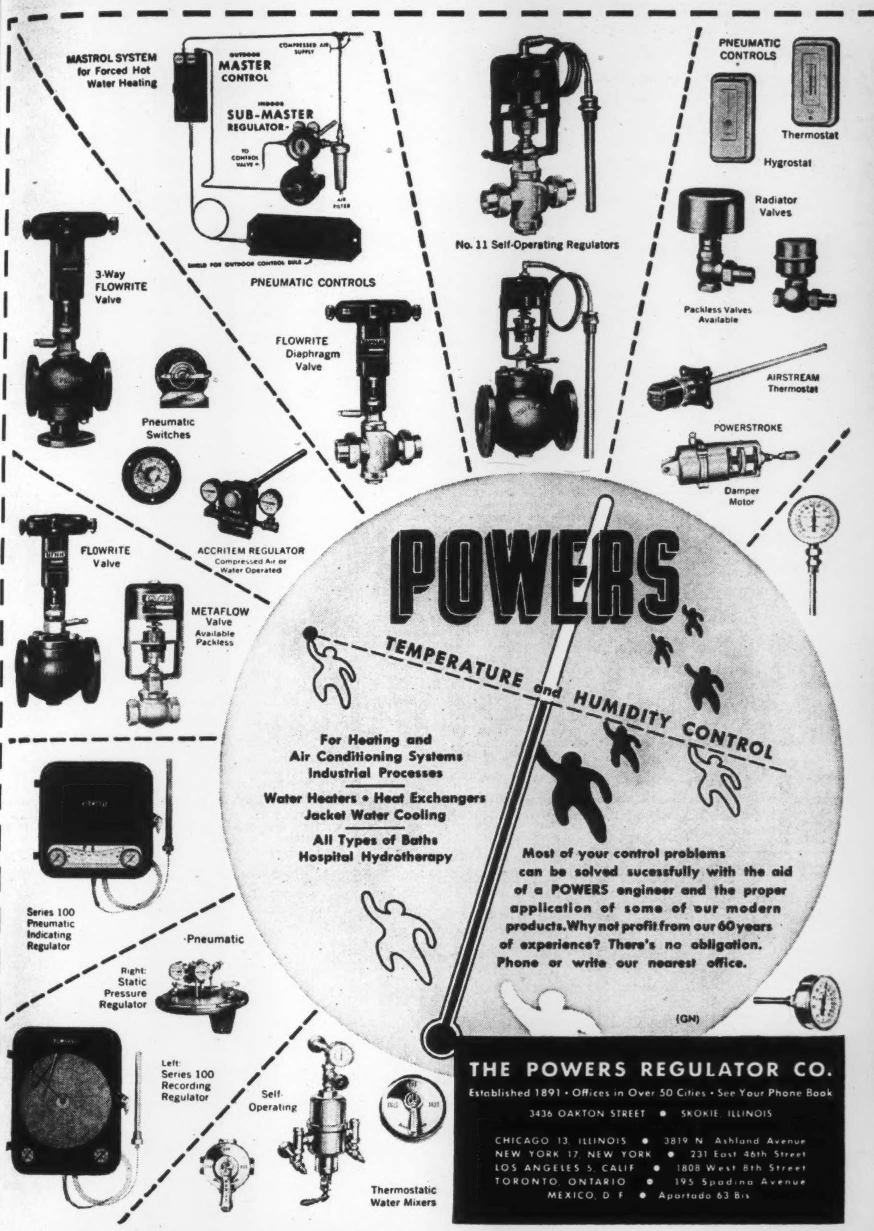
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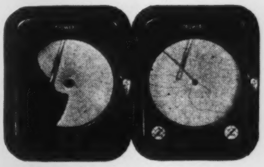
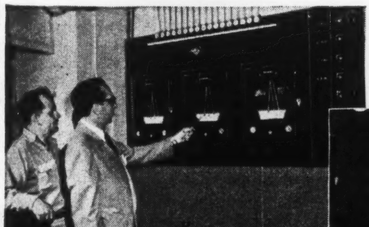
Above: At United Nations Hq. N. Y. one of the many Powers pneumatic air conditioning controls for Security Council and other large meeting halls.

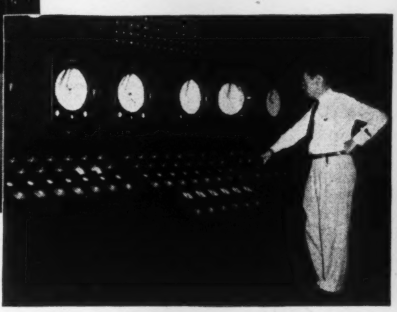
Above: Powers pneumatic temperature and humidity recorder-controller for wet and dry bulb control at the Bachmann Uxbridge Worsted Company.

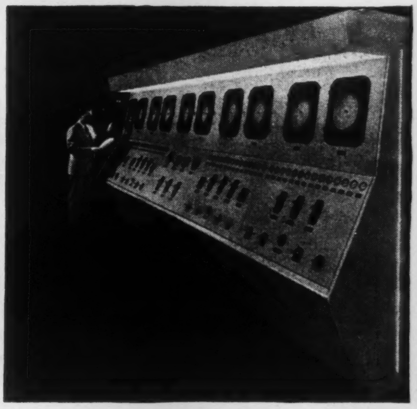

Above: Powers Time-Temperature Cycle recording controller.


Right: At Eglin Field, Fla., world's largest climatic test laboratory. Air conditioning is regulated by Powers Recorder Controllers and pneumatic switches for remote control of valves or dampers.

Right: Powers instruments on modern control panel for air conditioning systems in a prominent industrial plant.

Left: Powers air conditioning control instruments in a modern hotel.





Bailey FEED WATER Control

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(3) Bailey Three-Element feed water control is recommended for high capacity low water storage boilers operating at high pressures or for boilers operating at medium pressures with violent load fluctuations. This system is based on actual measurement of water flow to the boiler, steam flow from the boiler and water level within the boiler, and is adjusted primarily to control the rate of water flow to the boiler so that it equals the rate of steam flow from the boiler.

For detailed information consult Sweet's Engineering Catalogs or request bulletin ● No. 105.

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Builders-Providence
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Cutler-Hammer, Inc.
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Fisher Governor
Foxboro Co.
Fulton Sylphon Co.
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Hagan Corp.
Hammel-Dahl Co.
Hays Corp.
Henszey Co.
Kates Co., W. A.
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Lammert & Mann Co.
Lapp Insulator
Leeds & Northrup Co.
Leslie Co.
Mason-Neilan Regulator
McAlear Mfg. Div.
Mercon Regulator Co.
Milton Roy Co.
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North American Mfg.
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Republic Flow Meters Co.
Reynolds Gas Regulator
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Sampsel Time Control
Schutte & Koerting
Shallcross Controls
Simplex Valve & Meter
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Spence Engr. Co., Inc.
Tagliabue Div
Taylor Inst. Cos.
Wallace & Tiernan
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CONTROLLERS, AUTOMATIC, Fluid Proportioning (See Controllers Automatic, Flow Proportioning)

CONTROLLERS, AUTOMATIC, Frequency (See Regulators)

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Burrel Tech. Supply
Cash Co.
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Cook Electric Co.
Defender Automatic Reg.
Denver Fire Clay Co.
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Foxboro Co.
Fox Valley Inst.
Fuel Watchman
Fulton Sylphon Div.
General Controls
General Elec. Co.
General Regulator Corp.
Gleason-Avery, Inc.
Gordon Co., Claud S.
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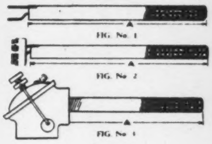

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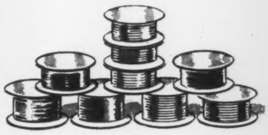

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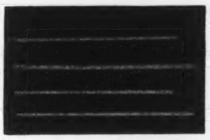

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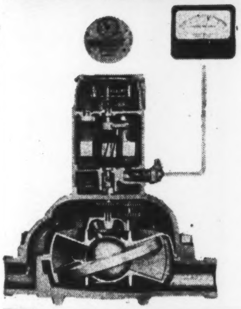

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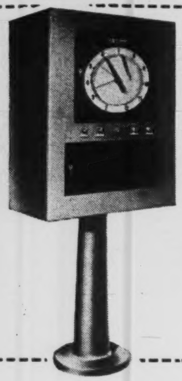

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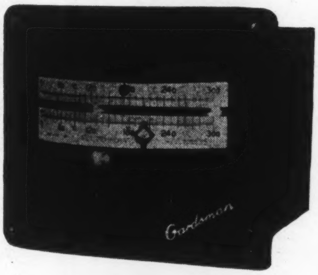

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Minneapolis-Honeywell
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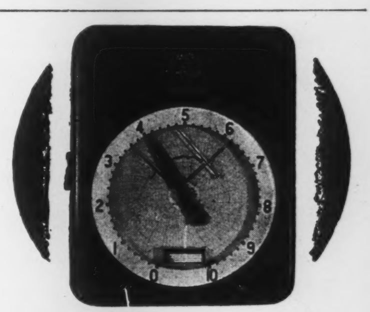

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Temperature Controller

● This BAILEY PYROTRON Electronic Resistance Thermometer indicates, records and controls temperatures between −100 F and 1200 F.

As many as four continuous temperature records may be made on a single 12-inch diameter chart. The 29-inch indicating scale is read easily at distances up to fifty feet.

Two recording controllers may be combined in one Bailey Pyrotron to save panel space. Air-operated, electric, or electronic controls are furnished as required.

Each recorder responds instantly since it is controlled by a separate measuring bridge and inertia free electronic detector. A small reversible electric motor balances the bridge and drives the indicating, recording and controlling features.

The temperature sensitive element is a platinum resistance wire wound on a mica form.

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Bailey Meter Company Ltd., Montreal, Canada

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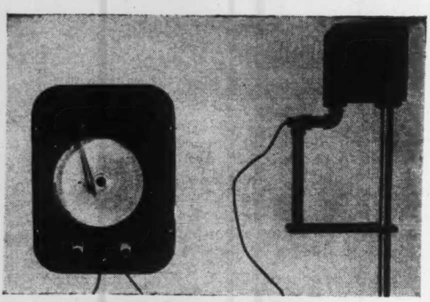
NORCROSS Recording and Recording Controlling Viscometers



Viscosity Range: 1 to 200,000 c.p.

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2. Operation under pressure or vacuum.
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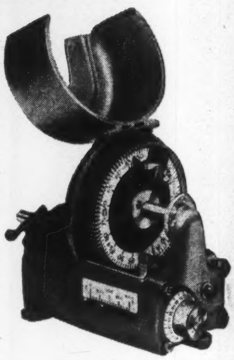

WHAT IT DOES: The "Cyclo-Monitor" momentarily opens or closes electric circuits to motors, magnetic brakes, signals, relays, solenoids, etc., based on a predetermined count. Repeats automatically—no count reading, checking or manual re-setting between cycles.

HOW IT OPERATES: Count pickup may be *mechanical* (based on rotation or stroke), or *electric* (through sensitive switch, photo-electric cell, etc.).

CONTROL RANGE: May be set for *any count* from 1 to 2,000, and *all even numbers* from 2,000 to 4,000. Extended ranges also available.

OPERATING SPEED: *Rotary counter*—up to 5,000 counts per min.; *stroke counter*—up to 1,000 counts per min.; *solenoid-operated counter*—up to 350 counts per min. Intermittent or continuous operation. No pause for re-set.

HOW CYCLE IS SET: Two simple adjustments instantly set unit for the desired count. Can be set in approximately 5 seconds.

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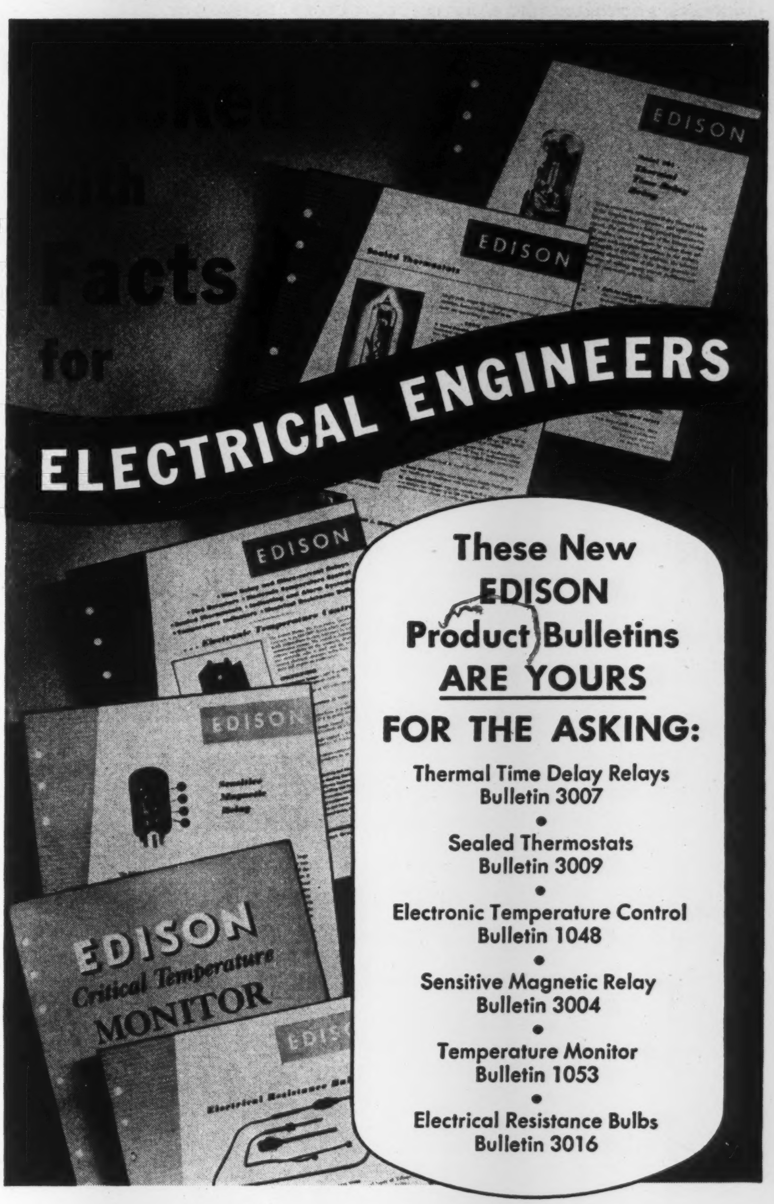

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DEPTH, Recorders, Liquid (See Gages, Liquid Level, Indicating)

DETECTOR CARS, For Testing Rails in Track
Sperry Products, Inc.

DETECTORS, Alpha
Abrams Instrument
Clarkstan Corp.
General Electric
General Radio
Kelley-Koett Inst. Div.
Loudon Insts.
MacDonald Co., W. S.
Nuclear Development Lab.
Nuclear Inst. & Chemical
Nuclear Res. & Dev.
Nucleonic Corp.
Radiation Counter Labs.
Radioactive Products
R-C Scientific Inst.
Special Instruments Lab.
Technical Associates
Tracerlab
Wood Counterlab

DETECTORS, Benzol
Baird Associates
Bristol Co.
Davis Emergency Equip.
Mine Safety Appliances

DETECTORS, Beta
Detectron Co.
General Electric
General Radio
Georator Corp.
Kelley-Koett Inst. Div.
Loudon Insts.
MacDonald Co., W. S.
Nuclear Development Lab.
Nuclear Inst. & Chemical
Nuclear Res. & Dev.
Nucleonic Corp.
Radiation Counter Labs.
Radioactive Products
R-C Scientific Inst.
Special Insts. Lab.
Technical Associates
Tracerlab
Western Radiation Lab.
Wood Counterlab

DETECTORS, Carbon Monoxide
Baird Associates
Bristol Co.
Davis Emergency Equip.
Mine Safety Appliances
Taller & Coper

DETECTORS, Combustible Gas
Bailey Meter Co.
Baird Associates
Bristol Co.
General Electric Co.
Johnson-Williams, Ltd.

DETECTORS, Fire
Airite Products Co.
American Communications
Clark Cooper Co.
Edison, Inc., Thos. A.
Fenwal, Inc.
G-V Controls
Photoswitch, Inc.

DETECTORS, Flaw
Aero Electronics
Branson Instrument
Dice Co., J. W.
Magnaflux Corp.
Magnetic Analysis Corp.
Sperry Products, Inc.

DETECTORS, Gamma
Beckman, Inc. Arnold O.
Consolidated Engr.
Detectron Co.
General Electric
General Radio
Georator Corp.
Kelley-Koett Inst. Div.
Loudon Insts.
MacDonald Co., W. S.
Menlo Research Lab.
Nuclear Development Lab.
Nuclear Inst. & Chemical
Nuclear Res. & Dev.
Nucleonic Corp.
Radiation Counter Labs.
Radioactive Products
R-C Scientific Inst.
Special Insts. Lab.
Technical Associates
Tracerlab
Western Radiation Lab.
Wood Counterlab

DETECTORS, Gas
Baird Associates
Beckman, Inc., Arnold O.
Bristol Co.
Bullard Co.
Davis Emergency Equip.
General Elec. Co.
Heiland Research
Johnson-Williams
Mine Safety App. Co.
Nuclear Inst. & Chem.
Process & Instruments
Victory Engr.

DETECTORS, Hazardous or Poisonous Gas
Davis Instruments
Johnson-Williams Ltd.
Mine Safety Appliances
Technical Associates

DETECTORS, Hydrogen Sulphide
Baird Associates
Davis Emergency Equip.
General Elec. Co.
Mine Safety Appliances

DETECTORS, Infrared
Hillyer Inst.
Liston-Folb
Mine Safety Appliances
Perkin-Elmer Corp.
Reeder & Co., C. M.
Servo Corp.

DETECTORS, Leak (See Gas Leak Indicators)

DETECTORS, Lie
Associated Research
Electro-Medical Labs.
Stoelting Co., C. H.

DETECTORS, Mercury Vapor
Central Scientific
General Elec. Co.
Mine Safety Appliances

DETECTORS, Metal
Aero Electronics
Allis-Chalmers
Associated Research
Detectron Co.
Du Mont Labs., Inc.
Fisher Research Lab.
General Elec. Co.
Geophysical Inst. Co.
Goldak Co.
Illinois Testing Labs.
McFarlin Co.
Menlo Research Lab.
Radio Frequency Labs.
RCA Div.
Streeter-Amet Co.
Wilmotte, Inc.

DETECTORS, Methane
Baird Associates
Bristol Co.
Bullard Co., E. D.
Davis Emergency Equip.
Heiland Research
Johnson-Williams
Mine Safety Appliances

DETECTORS, Microwave
Amer. Electroneering
Sperry Gyroscope Co.
Sperry Products
Sylvania Electric Prod.

DETECTORS, Mine Gases
Davis Emergency Equip.
Heiland Research
Mine Safety Appliances

DETECTORS, Neutron
General Electric
Georator Corp.
Kelley-Koett Inst. Div.
Nuclear Development Lab.
Nuclear Research & Dev.
Nucleonic Corp.
Radiation Counter Labs.
R-C Scientific Inst.
Wood Counterlab

DETECTORS, Oxygen, Deficiency
Beckman, Inc., Arnold O.
Davis Emergency Equip.
General Elec. Co.
Mine Safety Appliances

DETECTORS, Pin Hole
Hillyer Inst.
Vacuum Electronic Engr.

DETECTORS, Potential
Feller Engineering
General Elec. Co.
Geophysical Inst. Co.
Littelfuse Labs.
Minerallac Electric Co.
Sensitive Research Inst.
Varo Mfg. Co.
Westinghouse Elec.

DETECTORS, Radioactivity
Atomic Instrument
Beckman, Inc., Arnold O.
Berkeley Scientific
Canadian Radium
Cyclotron Specialities
Distillation Products, Inc.
General Elec. Co.
General Radio Co.
Geophysical Instrument
Goldak Co.
Herbach & Rademan
Kelley-Koett Inst. Div.
Menlo Research Lab.
Nuclear Instrument
Nuclear Research & Dev.
Radiation Counter Labs.
R-C Scientific Inst.
Scott, Inc., Hermon
Southwestern Ind. Elec.
Sylvania Elec. Prod.
Technical Associates
Tracerlab, Inc.
Victoreen Inst. Co.
Wood Counterlab.

DETECTORS, Radiation (Dosimeters)
Beckman, Inc., Arnold O.
Clarkstan Corp.
Cole Instrument
Consolidated Engr.
Georator Corp.
Kelley-Koett Inst. Div.
Menlo Research Lab.
Nucleonic Corp.
Process & Instruments
Radiation Counter Labs.
R-C Scientific
Technical Associates
Tracerlab
Western Radiation Lab.

DETECTORS, Radium
American Inst. Co.
Beckman Instruments
Berkeley Scientific
Canadian Radium
Detectron Co.
El-Tronics, Inc.
Fisher Research Lab.
Flett Lab.
Geophysical Inst. Co.
General Electric Co.
Goldak Co.
Kelly-Koett
Menlo Research Lab.
Morgan Instrument
Nuclear Dev. Lab.
Nuclear Inst. & Chem.
Radiation Counter Labs.
R-C Scientific Inst.
Rowe Engineering
Scott, Inc., Hermon
Stratex Instrument Co.
Technical Associates
Tracerlab, Inc.
Wood Counterlab.

DETECTORS, Vibration (See Vibroscopes)

DETECTORS, Voltage
Feller Engineering
Freed Transformer
General Elec. Co.
Gen. Physical Laboratory
Ideal Commutator Dresser
Industrial Control
Meter Devices Co.
Rockwell Engr. Co.
S & C Electric
Sherron Metallic
Westinghouse Elec.

DEW POINT INSTRUMENTS
American Instrument
General Electric
Illinois Testing Labs.
Powers Regulator
Refinery Supply Co.
Surface Combustion
Welch Scientific

DIAL INDICATORS, Dimensional
American Meas. Insts.
Ames Co., B. C.
Brown & Sharpe
Chicago Dial Ind. Co.
Deming Indicator
DoALL Co.
Federal Prod. Corp.
Ferner Co.
General Elec. Co.
Gen. Engg. & Model Wks.
Micro Master Co.
Scherr Co., Inc.
Scientific Inst. Co.
Sheffield Corp.
Size Control Co.
Stafford Co.
Standard Gauge
Standard Products Inc.
Starrett Co.
Testing Machines, Inc.
U. S. Radium Corp.

DIAL LIGHTS (See Pilot Lights)

DIAL MICROMETERS (See Micrometers, Dial)

DIALS & POINTERS
Johnson, E. R.
Precision Tube Co.
Superior Tube

DIFFERENTIAL PRESSURE (See Controllers, Gages, etc., Pressure)

DIFFRACTION GRATING (See Grating, Diffraction)

DILATOMETERS
American Inst. Co.
Bristol Co.
Canadian Radium
Dietert Co.
Ferner Co.
Gaertner Scientific Corp.
Instrument Dev. Labs.
Leitz, Inc., E.
Maveg Mach. Sales
Rockwell Co., Stanley P.
Sylvania Elec. Labs.
Zeiss, Inc., Carl

DIVIDERS, Voltage (Decade)
Cole Instrument
Daven Co.
Electronic Dev. Lab.
Feiler Engineering
General Radio
Gray Instrument
Shallcross Mfg.
Thwing-Albert Inst. Co.
Walkirt Co.
Ward Leonard Elec. Co.

DIVIDERS, Voltage (Radio Frequency)
Beck Bros.
Clarke Inst. Corp.
Daven Company
Electronic Associates
Feiler Engineering
Ferris Inst. Co.
General Elec. Co.
General Radio Co.
Instrument Resistors, Inc.
International Resistance
Kay Electric
Mallory & Co.
Measurements Corp.
Ohmite Mfg. Co.
Potter Instrument
RCA Manufacturing
Sensitive Research Inst.
Shallcross Mfg. Co.
Sherron Metallic
Televiso Co.
Ward Leonard Elec. Co.

DIVIDING HEAD, OPTICAL
American Meas. Insts.
Engis Equipment
Ferner Co.
Gaertner Scientific
Griswold Mfg. Co.
Hillyer Instrument
Jarrell-Ash Co.
Vinco Corp.
Webber Gage Co.
Zeiss, Inc., Carl

DIVIDING MACHINES
Brown & Sharpe
Engis Equipment
Ferner Co.
Gaertner Scientific Corp.
Hayes Scientific Apps.
Hillyer Inst.
Martin-Hubbard Corp.
Micro Instrument Co.
Precise Instrument Co.

DRAFT Indicators (See Gages, Draft) Recorders (See Gages, Draft)

DRAFT Controllers (See Controllers, Automatic Draft)

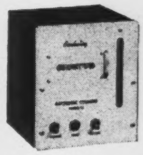
DRAWING INSTRUMENTS
Alina Corp.
Alpha Instrument Co.
Alteneder & Sons
Brown & Sharpe
Bruning Co., Inc.
Brush Development
Charvoz-Roos Corp.
Dietzgen Co.
Drafto Co.
Gurley, W. & L. E.
Henschel & Co.
Hopp Press
Instrumaster Industries
Ithaca Sci. Inst. Co.
Keuffel & Esser Co.
Lovins Engr.
Micro Master Co.
Millers Falls Co.
Nelson Section Liner
Noris Instruments
Post Co., Frederick
Precise Measurements Co.
Rapidesign Inc.
Reed Research
Speidel & Co.
Starrett Co., L. S.
Stratex Instrument Co.
Suverkrop Instruments
United States Blue Print
Universal Drafting Mach.
V. & E. Mfg. Co.
Warren-Knight Co.
Weber Co., F.
White Co., Inc., David
Williams, Brown & Earle

DRIFT INDICATORS
Driftmeters, Inc.
Eastman Oil Well
Eclipse-Pioneer Div.
Gurley, W. & L. E.
Kollmorgen Optical Co.

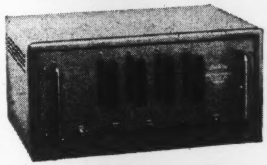
ELECTRONIC INSTRUMENTATION

for LABORATORY *or* PRODUCTION LINE!

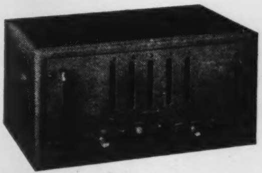
DECIMAL COUNTING UNIT, MODEL 700 is a direct reading electronic counter capable of operating at speeds up to 30,000 counts per second. Digits from 0 to 9 are presented on illuminated front panel. Electrical reset to zero. Plug-in octal mounting for easy interchangeability. The counter operates on input pulse of 100 volt neg. with 2 microsec. max. rise time. Output will drive following unit in cascade. Dimensions 1⅜"x5"x5¼". Wt. 12 oz. Other models to a million counts per second.



ELECTRONIC COUNTER, MODEL 10 was developed to meet the need for a rugged industrial counter operating at speeds up to 6000 counts per minute. Total count is displayed on the Decimal Counting Unit and the mechanical register to a maximum capacity of 9,999,999. Unit may be operated from closing contacts, photocell, or any means that will supply a positive potential of at least 3 volts. All circuitry moisture and fungus proofed. Unit is available in a variety of vapor-proof and explosion-proof housings to meet individual requirements. Dimensions 6¼" x 7¼" x 6½". Weight approximately 6 lbs.

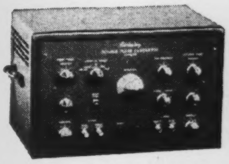


PRESET COUNTER consists of a series of scale-of-10 electronic counting units each in parallel with a 10-position push-button switch. This instrument accepts counts in the conventional manner at rates up to 10,000 cps. Any number from 0 to maximum capacity may be preset merely by depressing appropriate push-button in each column. Upon reaching the preset count, the unit supplies an output pulse to drive a register, close a gate, divert a production line or perform any other desired function. It then resets to 0 and recycles automatically. Available in any desired capacity.



EVENTS PER UNIT TIME METER, MODEL 554 will automatically count and display the number of events that occur during a precise one second interval at rates up to 100,000 events per second. Accuracy is ± one event. Will operate either manually or automatically to count any mechanical, electrical, or optical occurrences, regularly or randomly spaced, that can be converted into changing voltages. Instrument counts for one second and displays the results on illuminated five-digit panel. Will recycle continuously on automatic operation. Convenient test switch permits 2 second self-check of entire unit. Dimensions 20¾" x 10½" x 15". Weight approximately 68 lbs.

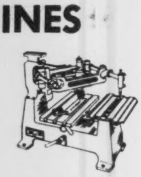
TIME INTERVAL METER, MODEL 510 provides a direct reading of elapsed time between any two events in the range of 0.000010 to 1.00000 seconds. Accuracy is ± 10 microseconds. Any occurrences that can be translated into changing voltages may be so timed. Timing may be started and stopped by independent voltages, the polarity of which may be selected by means of toggle switches. Sensitivity control permits selection of the amplitude of start or stop voltages at optimum level for elimination of interference. Dimensions 20¾" x 10½" x 15". Weight approximately 58 lbs.



SINGLE/DOUBLE PULSE GENERATOR MODEL 903 is a general purpose laboratory instrument that supplies either single or paired pulses individually variable in amplitude, width and polarity. Pulse spacing is continuously variable from 0 to 10 microseconds, pulse width from 0.10 to 1.6 microseconds and pulse amplitude from 200 volts maximum negative and 50 volts maximum positive for 1000 ohm load, and 10 volts maximum negative and 50 volts maximum positive for 50 ohm load. Single or double pulses are available through separate panel connectors. Repetition rate internally controlled 1 to 1000 cps. Push-button control single cycle. External signal control for any rate up to 1000 cps.

These are basic descriptions of representative standard instruments. A variety of modifications, both standard and special, are available to meet specific requirements. For complete details write Dep't. II.

Berkeley Scientific Corporation
2200 WRIGHT AVE. • RICHMOND, CALIF.
A NATIONAL ORGANIZATION



ENGRAVING MACHINES
by
PREIS

Preferred for Fast—Easy Engraving, Etching and Electric Marking of Lettering, Design, Calibrating and Numbering on Parts and Instruments of any Metal, Plastic or Other Material

Write for data

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661 State H'way 29, Hillside, N. J.

Kollsman Inst. Co.
Pioneer Instrument Co.
RCA Manufacturing
Servo Corp. of America
Thwing-Albert Inst. Co.

DRIFT INDICATORS, Bore Hole

Geophysical Inst. Co.
Sperry-Sun Well Surveying

DRYERS, Instrument Air (See Air Dryers)

DUROMETERS (See Testers & Testing Machines, Hardness)

DUST ANALYSIS APPARATUS

Baldwin-Lima-Hamilton
Central Scientific Co.
Corning Glass Works
Falstrom Co.
Federal Pneumatic Systems
Fisher Scientific Co.
Mine Safety Appliances
Pfaltz & Bauer, Inc.
Sargent & Co.
Scientific Glass Apparatus
Scientific Inst. Co.
Wilson Products, Inc.
Zeiss, Inc., Carl

DYNAMOMETERS, Hydraulic

Baldwin-Lima-Hamilton
Dynamatic Corp.
Emery Co., A. H.
Link Engineering
Monsell, J. R.
Olsen Testing Machine
Taylor Dynamometer

DYNAMOMETERS, Pull Rod

Baldwin-Lima-Hamilton
Conoflow Corp.
Dillon & Co.
Hathaway Inst. Co.
Hayes Scientific Apps.
Schaevitz Engg.
Seederer-Kohlbusch, Inc.
Statham Labs.
Stoelting Co., C. H.

DYNAMOMETERS, Rotary Absortion

Bristol Co.
Cole Instrument
Dynamatic Corp.
General Elec. Co.
L. A. B. Corp.
Link Engineering
Mid-West Dynamometer
Nankervis Co., G. L.
Taylor Dynamometer & Mach.

DYNAMOMETERS, Tension

Baldwin-Lima-Hamilton
Boulin Instrument Corp.
Chatillon & Sons
Coleman Inst. & Mfg.
Dillon & Co.
Emery Co., A. H.
Hathaway Inst. Co.
Olsen Testing Machine
Riehle Div.
Schaevitz Engg.
Seederer-Kohlbusch
Statham Labs.
Stoelting Co., C. H.
Thwing-Albert
Wiancko Engineering

DYNAMOMETERS, Transmission

Baldwin-Lima-Hamilton
Hathaway Instrument
Kellogg Switchboard
Link Engineering
Nankervis Co., G. L.
Rubicon Co.
Seederer-Kohlbusch

EARTH CURRENT METERS (See Meters, Earth Current)

EARTH RESISTANCE METERS

American Inst. Co.
Associated Research
Automatic Elec. Sales
Berkeley Scientific
Biddle Co., Jas. G.
Borden Engineering
Geophysical Inst. Co.
Gray Instrument
Heiland Research
Industrial Insts., Inc.
Miller. M.C.
Rawson Electrical Inst.
Rubicon Co.
Shallcross Mfg.
Sticht & Co.

EBULLIOMETERS

American Inst. Co.
Bellco Glass Inc.
Braun Corp.
Central Scientific Co.
Distillation Products, Inc.
Ferguson Co.
Fisher-Scientific
Kontes Glass Co.
Podbielniak. Inc.
Precision Scientific
Precision Therm.
Rascher & Betzold
Refinery Supply Co.
Tagliabue Div.

EBULLISCOPE (See Ebulliometers)

ECHELON GRATING (See Grating, Echelon)

ELECTRIC WAVE FILTER SECTIONS

Aerovox Corp.
Bailey Electric Co.
Berkshire Laboratories
Clarke Inst. Corp.
Clough-Brengle Co.
Electronic Dev. Lab.
Freed Transformer
General Radio Co.
Millen Mfg. Co.
Sherron Metallic
Southwestern Ind. Elec.
Standard Transformer
Thordarson Elec. Mfg.

ELECTROANALYSIS AP-APPARATUS

Aero Electronics
Burrell Tech. Sup.
Central Scientific
Coleman Electric
Eberbach & Son
Fisher Scientific
La Motte Chem. Prod.
Leitz, Inc.
Precision Scientific
Schaar & Co.
Servo Corp. of America
Sherron Metallic

ELECTROLYSIS INSTRUMENTS

Bristol Co.
Rawson Elec. Insts.
Welch Scientific
Weston Elec. Inst.

ELECTROMETERS, Quadrant

Cambridge Inst. Co.
Dittmore & Freimuth
Nuclear Inst. & Chem.
Pfaltz & Bauer, Inc.
Rawson Elec. Inst.
Rubicon Co.
Testrite Instrument Co.
Welch Mfg. Co.

ELECTROMETERS, String

Cambridge Inst. Co.
Dearborn Scientific
Dittmore & Freimuth
Geophysical Inst. Co.
Nuclear Inst. & Chem.
Pfaltz & Bauer, Inc.
Victoreen Instrument Co.

ELECTROMETERS, Vibrating Reed

Aero Instrument
Applied Physics Corp.
Furst Electronics
Loudon Insts.

ELECTRONIC EQUIPMENT SUPPLIERS

Sun Radio & Electronics
Walker-Jamieson

ELECTROPLATING SOLUTION TESTING APPARATUS

Central Scientific Co.
Federal Telegraph Co.
Fisher Scientific Co.
Hellige. Inc.
Industrial Insts., Inc.
National Tech. Labs.
Patwin Inst. Div.
Pfaltz & Bauer, Inc.
Sargent & Co.
Sherron Metallic
Taylor & Co., W. A.
Thwing-Albert Inst. Co.

ELECTROSCOPES

Canadian Radium
Central Scientific Co.
Chicago Apparatus Co.
Denver Fire Clay Co.
Geophysical Inst. Co.
Henson Co., Fred C.
Kelly-Koelt
Nuclear Inst. & Chem.
Pfaltz & Bauer, Inc.

ELLIPSOGRAPHS (SEE Drawing Instruments)

END MEASURES

Acme Industrial
Engis Equipment
Ferner Co.
Lufkin Rule
Pratt & Whitney
Sheffield Corp.

ENGINE INDICATORS See Indicators, Engine)

ENGINE INDICATOR REDUCING MOTION (See Reducing Motion, Engine Indicator)

ENGRAVING EQUIPMENT

Acromark Co.
Allied Engrav. & Stamping
DoALL Co.
Preis Engraving, H. P.
Stafford Co.

EUDIOMETERS

Ace Glass Inc.
Central Scientific Co.
Machlett & Son

EUSCOPES

Bausch & Lomb Optical
Stocker & Yale

EXPANSION TEST APPARATUS (See Testers, Expansion)

EXTENSOMETERS

American Inst. Co.
Baldwin Locomotive
Brabender Corp.
Cambridge Inst. Co.
Eitzen Co.
Federal Products Corp.
Ferner Co.
Gaertner Scientific
Gen. Engg. & Model Wks.
Hayes Scientific Apps.
Metzger & Son
Olsen Testing Machine
Rutishauser Corp.
Schaevitz Engineering
Statham Labs.
Swedish Gage

(Continued)

EYEGLASSES, POLARIZED (for Photoelastic Work or Strain Observation, etc.)

Polarizing Inst. Co.
Zeiss, Inc., Carl

FAULT LOCATORS, Communication Lines

Aero Electronics
Audio-tone Oscillator
Automatic Elec. Chicago
Borden Engineering
Century Geophysical
Dillon & Co.
General Electric
Industrial Insts., Inc.
Leeds & Northrup
Rawson Elec. Inst. Co.
Raytron, Inc.
Rubicon Co.
Shallcross Mfg. Co.
Tobe Deutschmann Corp.
Westinghouse Elec.

FEED WATER METERS

Bailey Motor Co.
Bristol Co.
Brown Inst. Div.
Builders-Providence
Central Station Steam
Elec. Indicator Co.
Fischer & Porter
Foxboro Co.
Hagan Corp.
Henszey Co.
Leeds & Northrup
Mason-Neilan Regulator
Republic Flow Meters
Simplex Valve & Meter
Sparling, R. W.

FEED WATER TESTING APPARATUS

Allis-Chalmers
Burrell Technical Supply
Central Scientific Co.
Hagan Corp.
Hellige, Inc.
Industrial Insts., Inc.
LaMotte Chemical Prod.
Leeds & Northrup Co.
Palo-Myers
Pfaltz & Bauer, Inc.
Photovolt Corp.
Taylor & Co., W. A.

FEEDERS, Automatic, Proportioning

Automatic Temp. Control
Bowser Inc.
Builders-Providence
Fischer & Porter
General Controls
Gump Co., B. F.
Henszey Co.
Lapp Insulator
Merrick Scale
Milton Roy Pumps
Omega Machine
Permutit Co.
Proportioneers, Inc.
Schaffer Paidometer Co.
Wallace & Tiernan

FEEDERS, Automatic Granular Material

Builders-Providence
Federal Classifier
Gump Co., B. F.
Merrick Scale
Omega Machine
Permutit Co.
Proportioneers, Inc.
Schaffer Paidometer Co.

FIELD-STRENGTH MEASURING SETS

Clarke Ints. Corp.
Empire Devices, Inc.
Federal Telephone
Ferris Inst. Corp.
General Elec. Co.
Marion Inst.
McFarlin Co.
Measurements Corp.
Panoramic Radio Co.
RCA Div.
Sherron Metallic
Tobe Deutschmann Corp.

FILLING MACHINES, Automatic

All Amer. Tool & Mfg.
Allis-Chalmers
Anderson Bros. Mfg. Co.
Automatic Scale
Baltimore Biological Lab.
Bowser Inc.
Gump Co., B. F.
National Inst.
Potter Instrument
Proportioneers, Inc.
Richardson Scale Co.
Stokes & Smith Co.
Triangle Package Mach.

FILTERS, Instrument Air

Anders Co.
Dollinger
Hankison Corp.
Pittsburgh Lectrodryer
Pritchard & Co.

FILTERS, Electrical Wave

Berkshire Laboratories
Cinema Engr.
Cole Instrument
General Radio
Gertsch Products
Gulton Mfg. Co.
Hycar Co.
Kay Electric Co.
Marconi Inst. Ltd.
Pacific Div.
Tobe Deutschman
Vectron, Inc.

(Continued)

FILTERS, Light (See also Filters, Optical)

American Inst. Co.
Baird Associates
Bausch & Lomb Opt.
Bell & Howell
Bolsey Corp.
Central Scientific Co.
Corning Glass Works
Crystal Research Labs.
Dearborn Scientific
Fish-Schurman Co.
Goerz Amer. Optical Co.
Kollmorgen Optical Co.
Leitz, Inc.
Palos Optical Co.
Perkin-Elmer Corp.
Precise Measurements Co.
Zeiss, Inc., Carl

FILTERS, Optical

Baird Associates
Bausch & Lomb Optical
Binswanger & Co.
Boehmke Optical Co.
Bolsey Corp.
Crystal Research Labs.
Dearborn Scientific
Eastman Kodak Co.
Electro-Physics
E & S Optical
Ferner Co.
Fecker, J. W.
Fish-Schurman
General Scientific Corp.
Geophysical Inst. Co.
Goerz Amer. Optical Co.
Hayward Optical Glass
Henson Co., Fred C.
Ice Optical Co., H. C.
Jones Optical Works
Klett Mfg. Co.
Palos Optical Co.
Perkin-Elmer Corp.
Pfaltz & Bauer, Inc.
Phoenix Precision Inst.
Photovolt Corp.
Precise Measurements Co.
Pyrometer Inst. Co.
Republic Lens
Rubicon Co.
Simpson Optical Mfg.
Testrite Instrument Co.
Triumph Mfg. Co.
Unertl Optical Co.
Univis Lens Co.

FINDERS, Valve Box

Detectron
Geophysical Inst. Co.
Globe Phone Mfg.
Goldak Co.
Wilder, R. S.

FIRE CONTROL INSTRUMENTS, MILITARY & NAVAL

Aero Electronics
Arma Corporation
Bausch & Lomb
Bell & Howell Co.
Betts & Betts
Daca Machine & Tool
Elec. Indicator Co.
Electronic Associates
Fecker J. W.
Ford Instrument
General Elec. Co.
H-B Instrument
Instrument Dev. Lab.
Kollmorgen Optical Co.
Librascope
Martin-Hubbard Corp.
Maxson Corp.
Perkin Elmer Corp.
Robinette Co., W. C.
Sperry Gyroscope Co.
Unertl Opt. Co.
Vectron, Inc.
Wiancko Engineering

FLASH POINT TESTERS (See Testers, Flash Point)

FLATNESS TESTERS (See Testers, Flatness, Light Wave)

FLATS, OPTICAL

Acme Scientific
American Lens
American Optical
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Binswanger & Co.
Bray Optical
Buechele, W.
Cal-Astro Optical Labs.
Central Scientific Co.
Clark & Sons
Crystal Research Labs.
Curtiss Labs.
Dearborn Scientific Co.
DoAll Co.
Dome Precision
Ednal Co.
Electro-Physics
Engis Equipment
E & S Optical
Fecker, Inc.
Ferner Co.
Fish-Schurman Co.
Fuess, Inc.
Gaertner Scientific Corp.
General Scientific Corp.
Geophysical Inst. Co.
Glendale Optical
Goerz Amer. Optical Co.
Hayward Scientific Glass
Henson Co., Fred C.
Herron Optical
Howland Optical Works
Ice Optical Co., H. C.

(Continued)

International Glass
Jarrell-Ash Co.
Jones Optical Works
Kollmorgen Optical Co.
Mann Co., Wm. I.
Master Optical Co.
Mico Instrument Co.
Miller Corp., William
Optron Laboratory
Pacific Optical
Palos Optical Co.
Penn Optical & Inst.
Perkin-Elmer Corp.
Phoenix Prec. Inst.
Plummer & Kershaw
Pratt & Whitney
Republic Lens
Ruska & Co.
Scherr Co., Inc., George
Sheffield Corp.
Schneider-Cogswell
Simpson Optical
Tinsley Laboratories
Unertl Optical Co.
Univis Lens Co.
Van Keuren Co.
Vinco Corp.
Wilder. R. S.
Zenith Optical Co.

FLATS, OPTICAL, Fused Quartz

Acme Scientific
American Lens
Bausch & Lomb Opt.
Cal-Astro Optical Labs.
Crystal Research Labs.
Dearborn Scientific
DoAll Co.
Dome Precision
Engis Equipment
E & S Optical
Fecker, Inc.
Fish-Schurman Corp.
Gaertner Scientific
Geophysical Inst. Co.
Henson Co., Fred C.
Howland Optical Co.
Ice Optical Co., H. C.
International Glass
Jarrell-Ash Co.
Jones Optical Works
Mann Co., W. I.
Optron Laboratory
Palos Optical Co.
Perkin-Elmer Corp.
Phoenix Prec. Inst.
Plummer & Kershaw
Scherr Co., Inc.
Sheffield Corp.
Simpson Optical Mfg.
Thermal Syndicate Ltd.
Tinsley Laboratories
Unertl Optical Co.
Van Keuren Co.

FLIGHT DIRECTION INDICATORS

Aero Electronics
Electro-Mec Lab.
Specialties. Inc.
Sperry Gyroscope Co.
Stafford Co.
Weston Elec. Inst.

FLIGHT TEST INSTRUMENTS

Aero Electronics
Applied Science Corp.
Electronic Associates
Federal Telegraph Co.
Gannon Co.
General Elec. Co.
Hathaway Instrument
Heiland Research
Impact Register
Lewis Engineering
M. B. Mfg. Co.
Revere Corp.
Sperry Gyroscope Co.
Statham Labs.
Televiso Products

"FLOW"

(Flowmeters measure primarily RATE of flow. For positive or "quantity" fluid meters, see the numerous classes under "Meters")

FLOWMETERS, AIR (See Flowmeters, Gas)

FLOWMETERS, AREA Cone & Disk Type

Commercial Research
Fischer & Porter
Friez Instruments
Hays Corp.
National Meter Co.
Phoenix Precision Inst.

FLOWMETERS, AREA Cylinder & Piston Type

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Bowser Inc.
Fischer & Porter
Hays Corp.
National Meter Co.
New Jersey Meter Co.
Phoenix Precision Inst.

FLOWMETERS, AREA, Free Float Type

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Commercial Research
Fischer & Porter
Fish-Schurman Corp.
Hammel-Dahl Co.
Hays Corp.
Hoke, Inc
Mercury Glass Co.
Penn. Ind. Inst. Corp.
Phoenix Prec. Inst.
Podbielniak, Inc.
Schutte & Koerting Co.

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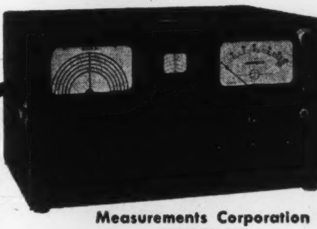

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Frequency Range
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POWER SUPPLY: Built-in supply, 117 volts AC, 6 volts DC.

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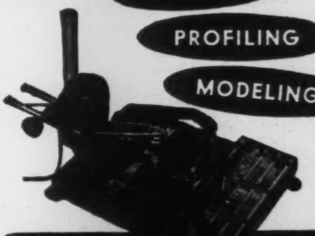

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Henszey Co.
Mason-Neilan Regulator
Meriam Inst. Co.
Minneapolis-Honeywell
Republic Flow Meters
Robinson **Orifice**
Simplex Valve & Meter
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, BLAST
(See Flowmeters, Gas)

FLOWMETERS, ELECTROMAGNETIC
Mittleman Electronics

FLOWMETERS, GAS
Ace Glass, Inc.
American Inst. Co.
American Meas. Insts.
American Meter Co.
Automatic Temp. Cont.
Bacharach Industrial Inst.
Bailey Meter Co.
Barton Inst. Co.
Bowser Inc.
Bristol Co.
Brooks Rotameter
Builders-Providence
Clark Blast Meter
Commercial Research
Cook Electric
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Eclipse-Pioneer Div.
Electric Heat Control
Elec. Indicator Corp.
Engelhard, Charles
Engr. Research & Dev.
Fischer & Porter
Fish-Schurman Co.
Foster Engg.
Foxboro Co.
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General Elec. Co.
Giannini & Co.
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Hastings Inst. Co.
Hays Corp.
Henszey Co.
Hoke, Inc.
Illinois Testing Labs.
International Filter Co.
King Engg. Corp.
Kollsman Inst. Co.
Laboratory Equip. Corp.
Leeds & Northrup
Leupold & Stevens

(Continued)

Linde Air Products
Mason-Neilan Regulator
Meriam Co.
Minneapolis-Honeywell
Mittelman Electronics
Moore Products
National Inst. Labs.
National Meter Co.
New Jersey Meter Co.
Northwest Instrument
Penn Ind. Inst. Corp.
Phoenix Prec. Inst.
Pitometer Log Corp.
Podbielniak, Inc.
Precision Scientific
Refinery Supply Co.
Republic Flow Meters
Revere Corp.
Schutte & Koerting Co.
Scientific Glass Apparatus
Sheffield Corp.
Simplex Valve & Meter
Statham Labs.
Superior Meter Co.
Tagliabue Div.
Taylor Inst. Cos.
Trimount Instrument
U. S. Gauge
Victory Engr.

FLOWMETERS, LIQUID
(See Flowmeters, Gas)

FLOWMETERS, Open-Stream
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Bristol Co.
Builders-Providence
Foxboro Co.
G. M. Mfg. Co.
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Hays Corp.
Leupold & Stevens
Mason-Neilan Regulator
Penn Ind. Inst. Corp.
Republic Flow Meters
Scientific Inst. Co. Calif.
Simplex Valve & Meter
Victory Engr.
Westberg Mfg. Co.
White Co.

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Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Barton Inst. Co.
Bristol Co.
Builders-Providence
Campbell Co., J. A.
Commercial Iron Works
Corning Glass Works
Daniel Orifice Fitting
Fischer & Porter
Foxboro Co.

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Hagan Corp.
Hays Corp.
Hoke, Inc.
Leeds & Northrup Co.
Leupold & Stevens
Mason-Neilan Regulator
Meriam Instrument
Minneapolis-Honeywell
Moore Products
National Inst. Labs.
Penn Ind. Inst. Corp.
Permutit Co.
Refinery Supply Co.
Republic Flow Meters
Robinson Orifice
Schutte & Koerting
Scientific Glass Apparatus
Scientific Inst. Co.
Simplex Valve & Meter
Tagliabue Div.
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, Pitot Tube
Am. Blower Corp.
American Meter Co.
Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Barton Inst. Co.
Bristol Co.
Cambridge Inst. Co.
Central Scientific Co.
Clark Blast Meter
Defender Automatic Reg.
Dwyer Mfg. Co.
Eclipse-Pioneer Div.
Ellison Draft Gage Co.
Foxboro Co.
Fries Instrument
Hagan Corp.
Hays Corp.
Illinois Testing Labs.
Kollsman Inst. Co.
Leupold & Stevens
Meriam Instrument
Morey & Jones, Ltd.
Pitometer Log Corp.
Precision Therm. & Inst.
Precision Tube Co.
Refinery Supply Co.
Republic Flow Meters
Revere Corp.
Simplex Valve & Meter
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, Steam
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Bailey Meter Co.
Barton Inst. Co.
Bristol Co.
Builders-Providence
Fischer & Porter
Foxboro Co.
Hagan Corp.

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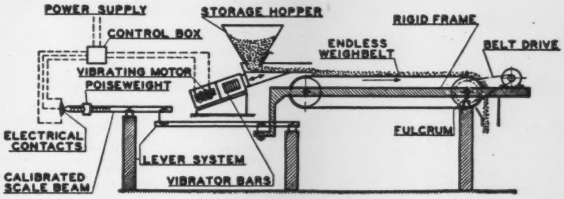

WEIGH FEEDERS . . .

The Jeffrey-Traylor WAYTROL is a high precision machine for accurate weighing, feeding, batching and proportioning. Vibrating feeder is weight-controlled. Rate of delivery automatically regulated through a weigh-belt mechanism. Accurate and flexible.

BIN-LEVEL INDICATOR

An instrument designed to show bin level at a glance. Can be used to control feed to bin, maintain a definite bin level, or control discharging equipment. Both units patented. Send for details.

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Birmingham 3
Boston 16
Buffalo 2
Chicago 1
Cincinnati 2
Cleveland 15
Denver 2
Detroit 13
Forty Fort, Pa.
Harlan, Ky.
Houston 2
Jacksonville 2
Milwaukee 2
New York 7
Philadelphia 3
Pittsburgh 22
St. Louis 1
Salt Lake City 1

Jeffrey Mfg. Co. Ltd., Montreal, Canada
Jeffrey-Galion (Pty.) Ltd., Johannesburg, S. A.
The Ohio Malleable Iron Co., Columbus, Ohio
British Jeffrey-Diamond Ltd., Wakefield, England
The Galion Iron Works & Mfg. Co., Galion & Bucyrus, Ohio
The Kilbourne & Jacobs Mfg. Co., Columbus, Ohio
Galion (Great Britain) Ltd., Wakefield, England

Water Calibration of Electronic Flow Meter 2½" size sensing element
Rotor speed rps
Differential pressure across electronic flow meter
Flow-pounds per second
0
10
20
30
40
50
60

POTTER *Electronic* FLOWMETER *and* TACHOMETER

NEWLY ENGINEERED

Eliminates Bearing Maintenance, Friction Drag, and High Pressure Drop

For difficult flow measuring problems involving high capacity, extremely corrosive liquids, gases, acids, and liquid oxygen.

Sensing Element: Standard unit handles 3500 PSI. Unaffected by pressure or temperature. Bearingless spinning rotor in pick-up unit permits operation in fluids carrying gritty particles.

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Simplex Valve & Meter
Tagliabue Div.
Taylor Inst. Cos.
Trimount Inst.

FLOWMETERS, Vane
Eclipse-Pioneer Div.
Friez Inst. Div.
Hays Corp.
Illinois Testing Labs.
Mason-Neilan Regulator
Simplex Valve & Meter

FLOWMETERS, Venturi-Type
American Meter Co.
Bailey Meter Co.
Barton Inst. Co.
Bristol Co.
Builders-Providence
Eclipse-Pioneer Div.
Foxboro Co.
Gauther, Donat A.
Hagan Corp.
Hays Corp.
International Filter Co.
Leeds & Northrup
Leupold & Stevens
Mason-Neilan Regulator
Minneapolis-Honeywell
Penn Ind. Inst. Corp.
Republic Flow Meters
Revere Corp.
Simplex Valve & Meter
Taylor Inst. Cos.
U. S. Gauge

FLOWMETERS, Weir
Bailey Meter Co.
Bristol Co.
Builders-Providence
Elec. Indicator Corp.
Fischer & Porter
Foxboro Co.
Gurley, W. & L. E.
Hagan Corp.
Hays Corp.
Leupold & Stevens
Mason-Neilan Regulator
Penn Ind. Inst. Corp.
Republic Flow Meters
Simplex Valve & Meter
Taylor Inst. Cos.

FLUE GAS ANALYZERS See Gas Analyzers, Flue Gas)

FLUID METERS, GAS (See Gas Meters)

FLUID METERS, LIQUID (See Meters, Liquid)

FLUID METERS, QUANTITY (See Gas Meters; Meters, Current; Meters, Liquid)

FLUORESCENT MERCURY VAPOR TUBES EMITTING WHITE LIGHT (See Light Sources)

FLUROMETERS
American Instrument
Coleman Electric
Farrand Optical
Menlo Research Lab.
Phoenix Precision Inst.

FLUOROSCOPES
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Kelley-Koett
Menlo Research Lab.
North American Phillips
Patterson Screen Div.
Picker X-Ray Corp.
Universal X-Ray Prods.
Westinghouse X-Ray Co.

FLUXMETERS
Annis Co.
Associated Research
Cambridge Inst. Co.
Central Scientific Co.
Clarke Inst. Corp.
Clarkstan Corp.
Fraser Dev. Lab.
General Elec. Co.
Leeds & Northrup Co.
Marion Electrical Inst.
Rawson Electrical Inst.
Rubicon Co.
Sensitive Research Inst.
Sticht Co.
Varian Associates

FOLDING ENDURANCE TESTERS (PAPER) (See Testers, Folding Endurance)

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Central Scientific Co.
De-Jur Amsco Corp.
General Elec. Co.
G-M Labs.
Hickok Elec. Inst.
Marion Elec. Inst.
MB Mfg. Co.
Pfaltz & Bauer, Inc.
Photovolt Corp.
Rockwell Engr.
Triplett Elec. Inst.
Welch Scientific
Weston Elec. Inst. Corp.

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Aero Electronics
Askania Regulator
Century Geophysical
Chatillon & Sons
Dillon & Co., W. C.
Engineering Res. & Dev.
Gulton Mfg. Co.
Industrial Electronics
Statham Labs.
Stewart Inst.
Wiancko Engineering

FOREWARN DETECTOR, for locating hidden weapons (See Detectors, Metal)

FORKS, Synchronization
American Time Prods.
Elec. Tachometer Corp.
Gaertner Scientific Corp.
Leeds & Northrup
MacLeod & Hanopol
Philamon Labs.
Riverbank Laboratories
Times Facsimile Corp.

FORKS, Tuning
American Time Prods.
Bunnell Co., J. H.
Clay-Adams Co.
Gaertner Scientific
General Electric Co.
Goetze Niemer Co.
Hathaway Instrument
Heiland Research
Philamon Labs.
Riverbank Labs.
Stoelting Co., C. H.
Times Facsimile Corp.

FORKS, Tuning, Electrically Driven
American Inst. Co.
American Time Prods.
Bunnell Co., J. H.
Cambridge Inst. Co.
Central Scientific Co.
Century Geophysical
Chicago Apparatus Co.
Electronic Prod. Co.
Elec. Tachometer Corp.
Engineering Labs., Inc.
Gaertner Scientific Corp.
General Electric Co.
General Radio Co.
Hathaway Inst. Co.
Leeds & Northrup
Metron Instrument
Philamon Labs.
Riverbank Laboratories
Sherron Metallic
Stoelting Co., C. H.
Times Facsimile Corp.
Varo Mfg. Co.
Welch Mfg. Co.

FORKS, Vacuum Driven
Cambridge Inst. Co.
Gaertner Scientific Corp.
General Radio
Philamon Labs.
Riverbank Laboratories
Times Facsimile Corp.

FRACTIONAL HORSEPOWER MOTORS (See Motors, Fractional Horsepower)

FRACTIONATING COLUMNS, Laboratory Glass
Glass Engr. Labs.
Kontes Glass Co.
Phoenix Precision Insts.
Podbielniak, Inc.
Uhrig Co., Joseph F.

FREENESS TESTERS (See Testers, Freeness)

FREQUENCY METERS, Controlling
Feiler Engineering
General Elec. Co.
Kellogg Switchboard
Leeds & Northrup Co.
Minnesota Electronics

FREQUENCY METERS, Electronic
Berkeley Scientific
Berkshire Labs.
Browning Labs.
Clarke Inst. Corp.
Cole Instrument
Conn, Ltd., C. G.
Daven Co.
De-Jur-Amsco Corp.
Electronic Dev. Lab.
El-Tronics, Inc.
Engineering Res. & Dev.
Federal Telephone
Feiler Engineering
Furst Electronics
General Elec. Co.
General Radio Co.
Gertsch Products
Harvey Radio Labs.
Hastings Inst. Co.
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Lavoie Laboratories
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Metron Instrument
Millen Mfg. Co.
Potter Instrument
RCA Div.
Rowe Radio Research
Sherron Metallic
Sylvan Electronic Labs.
Walkirt Co.

FREQUENCY METERS, Indicating
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Biddle Co., James B.
Burlington Inst. Co.
Electro-Tech. Equip.
Electronic Engineers
General Elec. Co.
General Radio Co.
Hagedorn Engineering
Hastings Inst. Corp.
Hathaway Instrument
Hickok Elec. Inst. Co.
J-B-T Instruments
Kellogg Switchboard
Leeds & Northrup Co.
Metron Instrument
Minnesota Electronics
Potter Instrument
RCA Div.
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Sensitive Research Inst.
Sperry Gyroscope Co.
Standard Elec. Time
Thordarson Elec. Mfg.
Triplett Elec. Inst.
Varo Mfg. Co.
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Westberg Mfg. Co.
West Coast Electronics
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Weston Elec. Inst. Corp.

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Amer. Electroneering
Berkeley Scientific
Browning Laboratories
Electro-Tech Equip. Co.
General Electric Co.
Kay Electric
Mico Instrument
Sperry Gyroscope Co.
Sylvania Elec. Prod.

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Cole Instrument
Engineering Res. & Dev.
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Metron Instrument
Minnesota Electronics
Potter Instrument
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FREQUENCY METERS, Standards
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General Electric Co.
General Radio Co.
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Kay Electric
Knights Co., James
Lampkin Laboratories
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Fisher Scientific Co.

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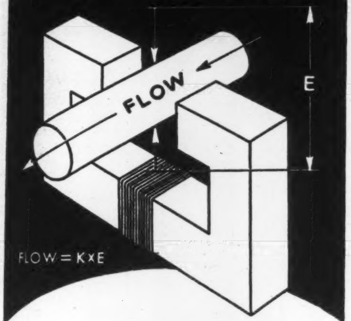
A NEW TOOL

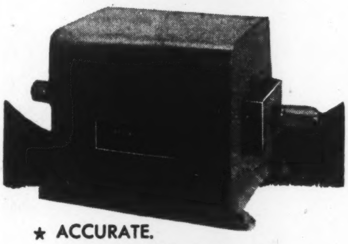
for

PRODUCTION,
PROCESS CONTROL
and RESEARCH



Magnaflow*

ELECTROMAGNETIC
FLOWMETER



★ ACCURATE.
★ INDEPENDENT of viscosity.
★ INDEPENDENT of pressure.
★ INDEPENDENT of flow whether turbulent or laminar.
★ RAPID RESPONSE to flow changes of 1,000 cps or higher.
★ NO OBSTRUCTIONS or constrictions, sensing tube same I. D. as flow line.
★ LINEAR OUTPUT facilitates proportioning, recording, integrating and tele-metering.
★ TEFLON, GLASS or STAINLESS STEEL sensing tube for corrosive chemicals or molten metals.

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Sargent & Co.
Tagliabue Div.

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Barton Inst. Co.
Bristol Co.
Brooks Rotameter
Brown Inst. Div.
Commercial Research
Eclipse-Pioneer Div.
Engineering Res. & Dev.
Fischer & Porter
Foxboro Co.
General Elec. Co.
Hastings Inst. Co.
Hays Corp.
Mason-Neilan Regulator
National Airoil Burner
Revere Corp.
Schutte & Koerting
Statham Labs.
Tagliabue Div.
Taylor Inst. Cos.

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Hevi Duty Electric
Huppert Co.
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Lindberg Engineering Co
Machlett & Son
Marshall Co., L. H.
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Precision Scientific
R-S Prod. Corp.
Selas Co.
Shallcross Controls
Surface Combustion
Tenney Engineering
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Dearborn Scientific
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Pratt & Whitney
Precision Scientific
Scherr Co., George
Size Control Co.
Standard Gage Co.
Swedish Gage
Van Keuren Co.
Webber Gage Co.

GAGE BLOCKS, Angle

Palos Optical Co.
Size Control Co.
Webber Gage Co.

GAGE BLOCKS, Surface Finish

Surface Checking Gage

GAGE COCKS

Manning, Maxwell & Moore
Marsh Corp.
U. S. Gauge
Weatherhead

GAGE GLASS ILLUMINATORS

Jerguson Gage & Valve
National Co.

GAGE TESTERS, Deadweight

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Amthor Testing Inst. Co.
Coleman Inst. & Mfg.
Crosby Steam Gage Co.
Darley Co., W. S.
Gordon Co., Claud S.
Grove Regulator
Manning, Maxwell & Moore
Mansfield & Green
Olsen Testing Machine
Precision Scientific
Refinery Supply Co.
Ruska Inst. Corp.
Trerice Co.

OVER-RANGING
will
not
damage

BARTON FLOWMETERS!

here's proof...

A user reports this test made on a BARTON Flowmeter with a 25" W.C. differential range at a pressure level of 1200 psi:

A 300 psi over-range pressure was alternately applied in the normal direction and then in the reverse direction approximately *20 times a minute,* continuously—day and night—*for three weeks!* At the conclusion of the test—after more than one-half million differential over-ranges in each direction—the instrument was checked for zero and calibration; *it had changed* less than one per cent! AND *no maintenance or parts replacement was required!*

less maintenance...

ALL MAJOR SOURCES OF TROUBLE inherent in other differential-pressure meters ARE ELIMINATED IN BARTON Rupture-Proof FLOWMETERS!

NO LIQUID SEALS TO LOSE—corrosive and volatile liquids are handled without seal pots, thus reducing installation and upkeep costs.

NO MERCURY USED—hence, no costly losses due to leakage or theft, and no contamination of liquid being handled. Likewise, installation can be made without accurate leveling.

EASY TO OPERATE—Unskilled personnel can put a BARTON in operation without danger of damage to the meter.

CLEANING ISN'T NEEDED—a BARTON drains or vents itself completely. No pockets to trap condensates. No floats, chains, or links to corrode. Assures permanent positive accuracy.

plus value features...

- Rupture-proof Stainless Steel Bellows.
- Torque-tube Drive—no pressure bearings.
- Pulsation Dampener—externally adjustable.

for measuring
FLOW • LIQUID LEVEL • DIFFERENTIAL PRESSURE

WRITE FOR DETAILS IN BULLETIN 11C4 TODAY!

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INSTRUMENT CORPORATION
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You Get Even, No Glare
LOW COST LIGHTING
for Gages, Rotameters, etc.
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JERGUSON
Explosion-Proof
GAGE
ILLUMINATORS

Single and Double Section Jerguson Illuminators on a 3-Section Gage.

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YOU get even, no glare, Low Cost Lighting with Jerguson Gage Illuminators . . . the improved illuminators that are unexcelled for gages, rotameters, etc. They give you ideal illumination with safety . . . and make possible faster, easier, accurate reading.

Jerguson Illuminators use the principle of solid wedge lighting to give you *clear, even lighting, without bright spots.* Light flows through the plastic wedge and is reflected evenly. A single small bulb gives you better illumination at a cost so low that savings quickly pay for the illuminator.

Jerguson Illuminators are approved by Underwriters' Laboratories and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. Made in a variety of sizes; also available in a non-explosion proof model.

Investigate Today. Write for Data Unit on Jerguson Illuminators

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GAGE TESTERS, Fluid scale
Crosby Steam Gage Co.
Manning, Maxwell & Moore
Refinery Supply

GAGE TESTERS, Liquid-column
Ideal Lab. Tool
Manning, Maxwell & Moore
Meriam Inst. Co.
Miller Falls Co.
Parks Co., Harry S.
Pioneer Instrument
Refinery Supply
Trerice Co.

GAGES (See also Object of Measuring and Control)

GAGES, Absolute Pressure
Bailey Meter Co.
Bristol Co.
Cook Electric
Distillation Products
Eclipse-Pioneer Div.
Emery Co., A. H.
Flader Inc., Frederic
Foxboro Co.
Fredericks Co., Geo.
General Elec. Co.
Giannini & Co.
Hathaway Inst. Co.
Hays Corp.
Kollsman Inst. Div.
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
Meriam Inst. Co.
Minneapolis-Honeywell
Moeller Instrument
Moore Products
Precision Thermometer
Scientific Inst. Co.
Servomechanisms, Inc.
Skaneateles Mfg. Co.
Statham Labs.
Tagliabue Div.
Taylor Inst. Cos.
Trans-Sonics, Inc.
Trimount Inst. Co.
Uehling Instrument Co.
United States Gauge
Wallace & Tiernan
Wiancko Engineering

GAGES, Adjustable Length
Acme Industrial
Barr Instrument
DoAll Co.
Federal Products Corp.
Merz Enginering
Nilsson Gage Co.
Saart, Kraemer & Hanscom
Scherr Co., George
Sheffield Corp.
Size Control Co.
Standard Gage
Swedish Gage
Woodworth Co.

GAGES, Air
American Chain & Cable
American Meter Co.
Bailey Meter Co.
Bastian-Blessing Co.
eacon Gage
Block Mfg. Co.
Bristol Co.
Dwyer Mfg. Co.
Eclipse-Pioneer Div.
Electric Auto-Lite
Federal Products
Fischer & Porter
Foxboro Co.
Friez Div.
Fulton Sylphon Div.
Hastings Instrument
Hays Corp.
Lambert Meter Co., Inc.
Manning, Maxwell & Moore
Marsh Corp.
Marshalltown Mfg.
Mason-Neilan Regulator
Meriam Inst. Co.
Merz Enginering
Moore Products
Parks Co., Harry S.
Pratt & Whitney
Rochester Mfg. Co.
Seely Inst. Co.
Sheffield Corp.
Statham Labs.
Tagliabue Div.
Taylor Inst. Cos.
Trerice Co
Uehling Inst. Co.
U. S. Gauge
Weksler Thermometer
Witt Gage Co.

GAGES, Air-gap
Federal Products

GAGES, Alarm
Acragage Co.
Bailey Meter Co.
Barton Inst. Co.
Bristol Co.
Brown Inst. Div.
Ellison Draft Gage Co.
Fischer & Porter
Foxboro Co.
Magnetrol, Inc.
Manning, Maxwell & Moore
Marsh Corp.
Marshalltown Mfg.
Mason-Neilan Regulator
Parks Co., Harry S.
Petrometer Corp.
Precision Therm. & Inst.
Rochester Mfg. Co.
Trerice Co.
U. S. Gauge
Weksler Thermometer
Wheelco Instruments

GAGES, Amplifying
Ames Co., B. C.
Comtor Corp.

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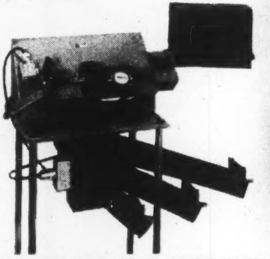

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GAGES, Automatic Sorting
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DoAll Co.
Electric Eye Equip.
Federal Products Corp.
Hathaway Instrument
Heyman Co.
Magnetic Gauge Co.
Martin-Hubbard Corp.
Merz Engineering
Pratt & Whitney
Rockwell Engr.
Rowe Engineering
Sheffield Corp.

GAGES, Bore
Brown & Sharpe
Commercial Research
Comtor Co.
Federal Prod. Corp.
Industrial Prod. Div.
Lufkin Rule Co.
Merz Engineering
Moore Products
Nilsson Gage Co.
Poole Instruments
Pratt & Whitney
Scherr Co.
Sheffield Corp.
Size Control Co.
Standard Gage
Swedish Gage
Vinco Corp.

GAGES, Bourdon
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Bastian-Blessing Co.
Beacon Gage Co.
Bristol Co.
Builders-Providence
Crosby Steam Gage
Dickson Co.
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Emery Co., A. H.
Esterline-Angus
Foxboro Co.
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Gorden Co., Claud S.
Gotham Inst. Co.
Hays Corp.
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Manning, Maxwell & Moore
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Marshalltown Mfg.
Mason-Neilan Regulator
Mercoid Corp.
Minneapolis-Honeywell
Perfex Corp.
Republic Flow Meters
Shallcross Controls
Sheffield Corp.
Taylor Inst. Cos.
Trerice Co.
United States Gauge
Weksler Thermometer
Welch Scientific
Wheelco Instruments
Witt Gage Co.

GAGES, Caliper (Dial)
Amer. Measuring Insts.
Ames Co., B. C.
Brown & Sharpe
Comtor Co.
DoAll Co.
Federal Prod. Corp.
Glogau & Co.
Marshall Co.
Nilsson Gage Co.
Sheffield Corp.
Size Control Co.
Starrett Co.
Waltham Dial Gage

GAGES, Center
Brown Sharpe
Bryant Chucking
Lufkin Rule Co.
Miller Falls Co.
Sheffield Corp.
Size Control Co.
Starrett Co.

GAGES, Coating Thickness
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Ames Co., B. C.
Branson Instruments
Gardner Laboratory
General Electric Co.
Industrial Nucleonics
Koehler Instrument

GAGES, Comparator
Amer. Measuring Insts.
Ames Co., B. C.
Menter Scope Inst.
Compar Inst. Co.
Comtor Co.
DoAll Co.
Eitzen Co.
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Hathaway Instrument

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Saart, Kraemer & Hanscom
Scherr Co.
Sheffield Corp.
Size Control Co.
Standard Gage
Stocker & Yale
Surface Checking Gage
Swedish Gage
Waltham Dial Gage
Woodworth Co.

GAGES, Compression
Bacharach Indus. Inst.
Baldwin Locomotive
Dillon & Co.
Electric Auto-Lite
Marsh Corp.
Olsen Testing Machine
Pratt & Whitney
Precision Scientific
Riehle Div.
Statham Labs.
Toledo Scale Co.
United States Gauge
Wiancko Engineering
Witt Gage Co.

GAGES, Concentricity
Engis Equipment
Federal Products
Saart, Kraemer & Hanscom
Sheffield Corp.
Size Control Co.
Swedish Gage Co.

GAGES, Continuous Thickness
Aero Electronics
Commercial Research
DoAll Co.
Electric Eye Equip.
Fedral Prod. Corp.
Foxboro Co.
Hathaway Instrument
Industrial Nucleonics
Magnetic Gauge Co.
Merz Engineering
Poole Manufacturing
Pratt & Whitney
Schaevitz Engg.
Sheffield Corp.
Starrett Co.
Telviso Products
Tracerlab Inc.
Waltham Dial Gage

GAGES, Continuous, Width
Aero Electronics
Barr Instrument

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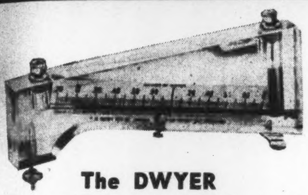
SENSITIVE —
DURABLE—
ACCURATE



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TRANSPARENT INCLINED GAGE
for
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for
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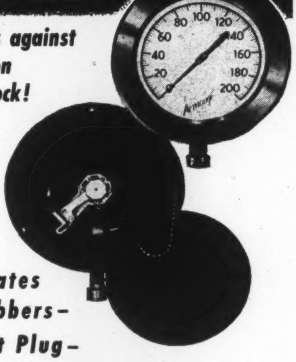
Shockstop!
PAT. APPLIED FOR



Protects against Pulsation and Shock!

Eliminates Snubbers–
It Can't Plug–

The Most Significant Pressure Gage Development in 50 Years.

For the first time, a successful means of eliminating the effect of pulsation and shock on pressure gage mechanisms has been developed which DOES NOT introduce an orifice or restriction in the pressure connection.

It Can't Plug

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WRITE FOR CATALOG C-50

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MILFORD, CONN.

DoAll Co.
Engineering Res. & Dev.
Federal Products Corp.
General Electric
Hathaway Instrument
Merz Engineering
Pratt & Whitney
Sheffield Corp.

GAGES, Contour see Gage, Profile

GAGES, Cylinder
American Gage Co.
Ames Co., B. C.
Brown & Sharpe
Comtor Co.
Dearborn Gage Co.
Elgin National Watch
Federal Prod. Corp.
Lufkin Rule Co.
Merz Engineering
Nilsson Gage Co.
Poole Instruments
Pratt & Whitney
Rimat Machine
Sheffield Corp.
Size Control Div.
Standard Gage
Starrett Co.
Swedish Gage

GAGES, Dead Weight
American Instrument
Ames Co., B. C.
Beacon Gage
Coleman Inst. & Mfg.
Eastern Specialty
General Electric
Gordon Co., Claud S.
Grove Regulator
Link Engineering
Manning, Maxwell & Moore
Mansfield & Green
Marshalltown Mfg.
Parks Co., Harry S.
Ruska Inst. Corp.
Swedish Gage Co.

GAGES, Depth, Linear
Alina Corp.
Amer. Measuring Insts.
Ames Co., B. C.
Brown & Sharpe
Carson Micrometer
DoAll Co.
Federal Products Corp.
General Elec. Co.
Glogau & Co.
Jansson Gage Co.
Lincoln Park Tool & Gage
Lufkin Rule Co.
Merz Engineering
Millers Falls
Park Sales
Petrometer Corp.
Pratt & Whitney
R & M Mfg. Co.
Ryan Tool & Engg.
Saart, Kraemer & Hanscom
Shand & Jurs Co.
Sheffield Corp.
Size Control Co.
Standard Gage
Starrett Co.
Swedish Gage
Vapor Recovery System

GAGES, Depth, Navigational
Pacific Div.
Geophysical Inst. Co.
G. M. Mfg. Co.
King Engineering Corp.
Negus, T. S. & J. D.
Parks Co., Harry S.
U. S. Gauge

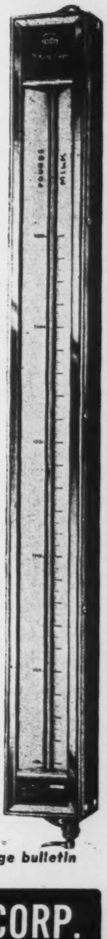
GAGES, Dial, Machinists'
Alina Corp.
American Meas. Insts.
Ames Co., B. C.
Brown & Sharpe
Chicago Dial Ind.
DoAll Co.
Eitzen Co.
Federal Prod. Corp.
Ferner Co.
Genales, Andrew
General Engg. & Model
Micro Master Co.
Nilsson Gage Co.
Sheffield Corp.
Size Control Co.
Standard Gage
Starrett Co.
Swedish Gage Co.

GAGES, Differential Pressure
Aeromarine Inst. Co.
American Meter Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Barton Inst. Co.
Beacon Gage Co.
Pacific Div.
Bristol Co.
Builders-Providence
Cleveland Fuel Equip.
Crosby Steam Gage
Defender Automatic Reg.
Dwyer Mfg. Co.
Ellison Draft Gage Co.
Emery Co. A. H.
Engineering Res. & Dev.
Flader, Inc., Fredric
Foxboro Co.
Friez Instrument
Gas Appliance Specialities
Gauthier, Donat A.
General Elec. Co.
Hathaway Inst. Co.
Hays Corp.
Kollsman Inst. Div.
Leupold & Stevens
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
Meriam Instrument

(Continued)

In pumproom of leading plastics manufacturer, King-Gages keep a weight check on liquid chemicals in storage. Other King-Gages weigh these liquids into stills and mixing tanks.

The King-Gage
Measures WEIGHT, VOLUME or DEPTH of Liquids in Storage or in Process



WEIGHS liquids in mixing and formulating—much faster than weigh tanks.

MEASURES acids, solvents, soap, tar, latex, milk, etc., where other methods are impractical, impossible or hazardous.

WIDELY USED in Food, Chemical, Marine, Beverage, Petroleum and many other industries—since 1928.

FEATURES
- Used with all types of tanks, vats and containers—open or closed.
- Can be located wherever desired—above or below tank, and at any distance up to many hundreds of feet.
- Reads directly in pounds or gallons.
- Permits accuracy of 1/4% or better over long service life. No mechanical or electrical parts; works as a frictionless balance.
- Backed by complete engineering service.

SPECIFICATIONS

SIZES: Five standard sizes, with 12", 20", 28", 35" and 43" scales. Larger sizes available for special applications.

SCALES: Graduated in any desired units of depth, weight or volume, or in any *two* units where desired.

LIQUID: Mercury, for most depths over 12 ft.; No. 294 Red Liquid for most depths up to 12 ft.; or No. 120 Green Liquid, for depths to about 5 ft. where scale with widely-spaced graduations in small increments is wanted.

FURNISHED with built-in hand pump, or for connection to compressed air supply. Available with glass overflow check valve integral with glass tube.

INSTALLED, calibrated and serviced by the King Engineer in your territory.

FOR FULL DETAILS, write for illustrated 12-page King-Gage bulletin—or tell us your liquid-measurement problem.

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KING ENGINEERING CORP.
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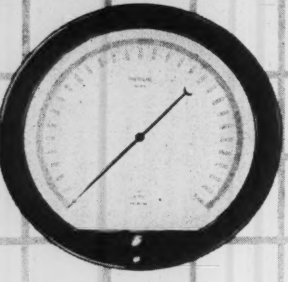
Flow Snubbers—Sediment Traps—D. P. Transmitters



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STANDARD OF THE WORLD

for measurements

of pressure

of extreme accuracy

- √ A design for every application
- √ Accurate to 0.2% of scale or better
- √ Minimum hysteresis and creep
- √ Revolving dial zero adjustment
- √ "In place" bleeding of air
- √ Special designs for use with mercury

For the unusual pressure gauge application — where extreme accuracy and stability under continuous-use or other exacting conditions are essential — Heise Gauges can be specified with confidence.

Manufactured on special order only in ranges from 0-15 to 0-10,000 psi. Sizes: 8½", 12" and 16". Prices: $151.60 to $211.20. Write for catalog.

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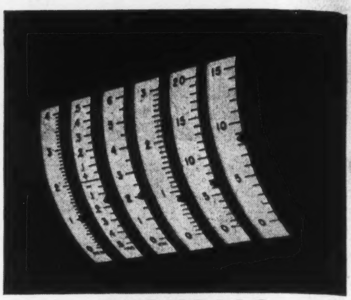
Newtown, Connecticut



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Republic multi-point indicators are supplied for all ranges of draft, pressure and differentials encountered in furnace operation in any desired combination.

Indicating units are interchangeable and are operated by a dry-bellows type of diaphragm. The 12-inch vertical, translucent scales are illuminated from the rear. All adjustments are made from the front of the panel and each unit may be withdrawn without disturbing others.

WRITE FOR DATA BOOK No. 802

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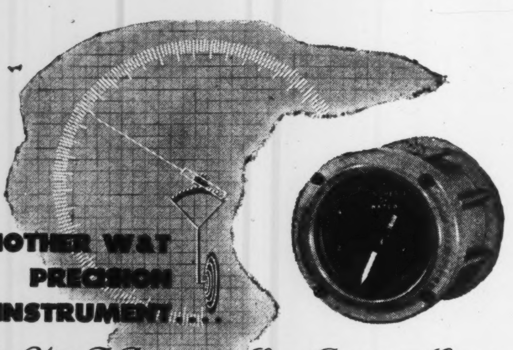
2240 Diversey Pkwy. Chicago 47, Ill.

REPUBLIC
INSTRUMENTS • CONTROLS



ANOTHER W&T PRECISION INSTRUMENT . . .

The W&T Precision Low Pressure Gauge

The W&T Precision Low Pressure Gauge has proved to be the answer to the problem of measuring low pressure accurately by successful use in such fields as aircraft flight testing, automotive research work, and engine and ventilation studies. Built with custom care from its beryllium copper capsule to its individually calibrated dial, the W&T Low Pressure Gauge is a precision instrument of the highest grade.

Here are some of its outstanding features:
Sensitive to 1 part in 500
Available in ranges from 0-10" of water to 0-400" of water
Measures differential pressure
Unaffected by gravity or acceleration
Equipped with expanded scale if desired

Write now and tell us your low pressure measuring requirements. We'll be glad to help — no obligation, of course.

A-78

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Pitometer Log Corp.
Precision Scientific
Precision Therm.
Preferred Utilities Mfg.
Republic Flow Meters
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Scientific Glass Apparatus
Scientific Inst. Co.
Servomechanisms, Inc.
Sheffield Corp.
Simplex Valve & Meter
Statham Labs.
Tagliabue Div.
Taylor Inst. Cos.
Thermo Instruments
Trerice Co., H. O.
Trimount Instrument
Uehling Instrument Co.
U. S. Gauge
Victory Engr. Co.
Weksler Thermometer
Wiancko Engineering
Witt Gage Co.

GAGES, Draft (See Gages, Differential Pressure)

GAGES, Drill Grinding
Brown & Sharpe
Dearborn Gage Co.
Lufkin Rule Co.
Starrett Co.

GAGES, Feeler
Acme Industrial
American Meas. Insts.
Brown & Sharpe
Dearborn Gage Co.
Elgin National Watch
Engis Equipment
Lufkin Rule Co.
Millers Falls Co.
Size Control Co.
Starrett Co.
Swedish Gage
Van Keuren Co.
Vinco Corp.

GAGES, Flush Pin
Acme Industrial
Allen Gauge & Tool Co.
American Gage Co.
Amer. Measuring Insts.
Cadillac Gage Co.
Dearborn Gage Co.
Elgin National Watch
Federal Products Corp.
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Jansson Gage Co.
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Merz Engineering
Nilsson Gage Co.
Saart, Kraemer & Hanscom
Sheffield Corp.
Sixe Control Co.
Swedish Gage
Vinco Corp.
Woodworth Co.
West & Dodge Thread

GAGES, Gas
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Bailey Meter Co.
Bastian-Blessing
Bristol Co.
Connelly Co.
Dickson Co.
Foxboro Co.
Gas Appliance Specialities
General Elec. Co.
Hays Corp.
Linde Air Products
Manning, Maxwell & Moore
Mason-Neilan Regulator
Marsh Corp.
Meriam Instrument
Parks Co., Harry S.
Republic Flow Meters
Rochester Mfg. Co.
Specialty Glass Co.
Statham Labs.
Superior Meter Co.
Tagliabue Div.
Taylor Inst. Cos.
Uehling Instrument
Witt Gage Co.

GAGES, Grinding
Acme Industrial
American Meas. Insts.
Ames Co., B. C.
Brown & Sharpe
Comtor Co.
Dearborn Gage Co.
Elgin National Watch
Engineering Res. & Dev.
Federal Prod. Corp.
Lufkin Rule Co.
Master Gauge
Merz Engineering
Moore Products
Nilsson Gage Co.
Sheffield Corp.
Size Control Co.
Swedish Gage Co.

GAGES, Grinding Finish
General Electric Co.
Surface Checking Gage

GAGES, Height
Allen Gauge & Tool Co.
Amer. Measuring Insts.
Ashton Valve Co.
Barr Instrument
Brown & Sharpe
DoAll Co.
Federal Products Corp.
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General Engg. & Model
Jansson Gage Co.
Leupold & Stevens
Lufkin Rule Co.
Merz Engineering
Park Sales Co.
Pratt & Whitney
Ryan Tool & Engg.
Scherr Co.
Sheffield Corp.
Size Control Co.
Standard Gage
Starrett Co.
Swedish Gage Co.
Vapor Recovery Systems

GAGES, Hook
Dwyer Mfg. Co.
Friez Instruments
Gurley, W. & L. E.
Leupold & Stevens
Lufkin Rule Co.
Scientific Inst. (Calif.)
Swedish Gage Co.
White Co., Inc.

GAGES, Hydrostatic (See Gages, Liquid Level, Indicating)

GAGES, Internal Dial
Ames Co., B. C.
Byrant Chucking Grinder
Comtor Co.
DoAll Co.
Federal Products Corp.
Gn. Engg. & Model Wks.
Merz Engineering
Nilsson Mfg. Co.
Scherr Co.
Sheffield Corp.
Size Control Co.
Standard Gage
Swedish Gage

GAGES, Ionization
General Electric
Nucleonic Corp.
Process & Instruments
Radiation Counter Labs.
Stoelting Co., C. H.
Tracerlab

GAGES, Limit
Acme Industrial
Amer. Measuring Insts.
Brown & Sharpe
Dearborn Gage Co.
Detroit Tap & Tool
Federal Products Corp.
Fonda Gage
General Elec. Co.
Greenfield Tap & Die
Jansson Gage Co.
Metron Instrument
Merz Engineering
Pratt & Whitney
Sheffield Corp.
Size Control Co.
Standard Gage
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Helicoid
Gage
U.S.A.

Helicoid Gage Division

AMERICAN CHAIN & CABLE COMPANY, INC.

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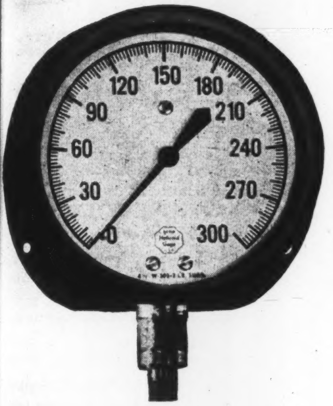
ONLY HELICOID GAGES HAVE THE HELICOID MOVEMENT

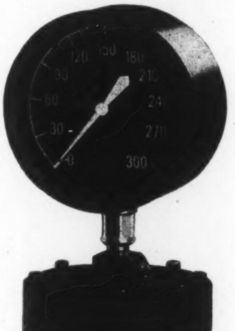


The new ACALOY case for Helicoid gages is a high compression molded aluminum alloy. Treated by patented process to prevent corrosion. Weatherproof. Greater strength—less weight. Durable baked-on finish. Neoprene gasket. Stainless steel (18-8) snap ring. Made with a back flange for surface mounting, and without a flange for stem mounting.

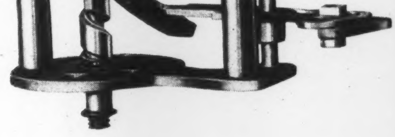
Rear view of ACALOY case shows safety blow-out discs supplied when specified. The discs are Bakelite, and are held by stainless steel snap rings. The safety discs release when the pressure in the case increases slightly. The glass front of the gage withstands approximately 35 p.s.i. in the 4½" dial size. Extra charge for safety blow-out discs.

40
50
60
30
70
20
80
10
90
0
100

Weather-proof, molded Phenol Turret Case. Rugged, non-corroding, will not warp or crack, permanent, natural black finish. Stainless steel snap ring. Neoprene sealing gasket. Moisture-proof front. Supplied with bottom or back connection, for surface or stem mounting. Made in 4½", 6", and 8½" dial sizes.

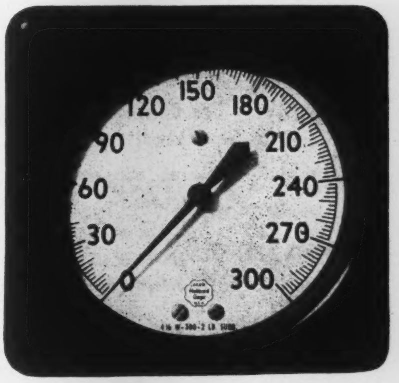


HELICOID CHEMICAL GAGE for any pressure up to 2,500 p.s.i., for vacuum and compound gages; temperatures up to 300° F. Particularly for chemicals and other viscous liquids. Diaphragm made of TEFLON or KEL-F, depending on service, which resists practically all corrosive chemicals. Bottom part supplied of any metal most suitable for the service. Made in 4½", 6" or 8½" dial sizes. 1" female bottom connection.



THE HELICOID MOVEMENT

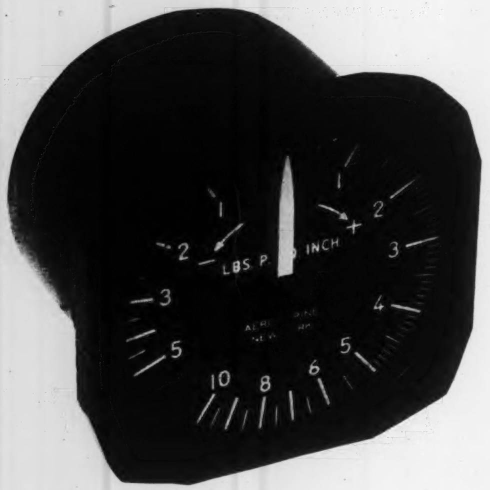
In the Helicoid movement, motion is transmitted by a cam contacting the helical groove in a roller. Cam facing is polished, graphited Bakelite. Helical groove in roller is highly polished stainless steel. Hairline adjustment of pointer is made with screw driver from back of case. Link adjusting screw is at rear so that calibration is possible without removing dial or pointer. Connecting link and screws are K Monel.



HELICOID SQUARE FLUSH CASE GAGE for symmetrical panels saves space and improves appearance. Width of the square front flange is less than the diameter of the conventional round front flange. Available in 4½", 6" and 8½" dial sizes in all standard pressure ranges; with or without internal illumination, white or ultra violet light.

Aeromarine

LOW PRESSURE APPLICATIONS



INDUSTRIAL:

Pressure gauges:
Ranges from 0 - 10 inches of water
up to 0 - 30 P.S.I.

Vacuum gauges:
Ranges from 0 - 10 inches of water
up to Full vacuum

Differential Pressure Gauges:
Ranges: Same as Pressure gauges

Compound:
Both Pressure and Vacuum readings on dial (as illustrated)

These gauges are available with linear, expanded, or retarded dials.

AIRCRAFT:

Flight instruments, both civilian and Air Force.

MARINE:

Marine Speed Indicators

AEROMARINE INSTRUMENT CO. INC.
385 Gerard Ave.
New York 51, New York

Swedish Gage
Van Keuren Co.
West & Dodge
Woodworth Co.

GAGES, Linear Measuring

DoAll Co.
Federal Products
Gaertner Scientific
Gulton Mfg. Co.
Hillyer Inst.
Industrial Electronics
Saart, Kraemer & Hanscom
Sheffield Corp.
Starrett Co., L. S.
Statham Labs.
Swedish Gage Co.

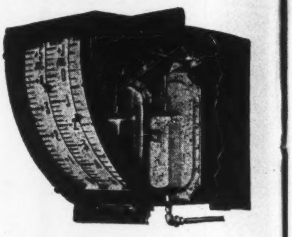
GAGES, Liquid Level Indicating

Acragage
American Meter Co.
Assoc. Valve & Engrg.
Autocall Co.
Automatic Control Co.
Automatic Temp. Control
Bacharach Industrial Inst.
Bailey Meter Co.
Barton Inst. Co.
Bastian-Blessing
Bin-Dicator Co.
Boston Auto Gage
Bowser & Co.
Bristol Co.
Builders-Providence
Bunnell Co., J. H.
B. W. Controller
Canadian Radium
Climax Div.
Control Corp.
Cook Electric
Crosby Steam Gage
Davis Reg. Co.
Defender Automatic Reg.
Dickson Co.
Dwyer Mfg. Co.
Eclipse-Pioneer Div.
Electric Auto-Lite
Elec. Indicator Corp.
Electric Tachometer Corp.
Elematic Equip. Co.
Electronic Prod. Co.
Engineering Research Ass.
Fischer & Porter
Fisher Governor Co.
Foxboro Co.
Frick Co.
Friez Instrument Div.
General Controls Co.
General Elec. Co.
Gorrell & Gorrell
Gotham Inst. Co.
Gray Instrument
Guardian Electric
Gurley, W. & L. E.
Hammel-Dahl Co.
Hathaway Inst. Co.
Hays Corp.
Instrument Lab., Inc.
Jerguson Gage Co.
Johnston & Jennings
Keckley Mfg. Co.
Kellogg Switchboard
King Engineering
Klingerit, Inc.
Leeds & Northrup Co.
Leupold & Stevens
Liquidepth Indicators
Liquidometer Co.
Lufkin Rule Co.
Lumenite Elec. Co.
Magnetrol, Inc.
Manning, Maxwell & Moore
Marsh Corp.
Marshalltown Mfg.
Mason-Neilan Regulator
McAlear Mfg.
McNeill Engineering
Meriam Instrument
Minneapolis-Honeywell
Moore Products
Natural Gas Equipment
Paragon Electric
Parks Co., Harry S.
Penberthy Injector Co.
Photoswitch, Inc.
Pitometer Log Corp.
Pneumercator Co., Inc.
Positel Mfg. Co.
Precision Therm.
Preferred Utilities Mfg.
Reliance Gauge Column
Republic Flow Meters
Revere Corp.
Rochester Mfg. Co.
Rosen Engg. Prods.
Schutte & Koerting Co.
Shand & Jurs Co.
Simmonds Aerocessories
Simplex Valve & Meter
Smith Corp., A. O.
Statham Labs.
Tagliabue Div.
Taylor Inst. Cos.
Thermo Instruments
Trerice Co.
Trimount Instrument
U C Indicator Sales
Uehling Instrument Co.
U. S. Gauge
Vapor Recovery Systems
Viking Instruments
Wallace & Tiernan
Weksler Thermometer
Warrick Co.
Westinghouse Elec. & Mfg.
Wheelco Inst. Co.
Wiancko Engineering
Williams Gauge Co.
Watt Gage Co.
Yarnall-Waing Co.

GAGES, Liquid Level, Recording (See Gages, Liquid Level, Indicating)

Bailey Meter Co.
Barton Inst. Co.
Bristol Co.

(Continued)



BAILEY
MULTI-POINTER
GAGES

● Bailey Multi-Pointer Gages are made with any number of pointers and any scale combination from one to twelve. The pointers have 10" motion over plainly marked plastic molded scales so that readings can be taken at a distance of 20 feet. Diaphragm actuated elements enable this gage to withstand over-drafts and over-pressures without injury to the unit or its calibration.

All secondary factors such as draft, pressure, temperature, stoker speed and pulverizer feed can be indicated on one Bailey Multi-Pointer Gage.

BAILEY METER COMPAN
1041 IVANHOE ROAD · CLEVELAND, O
Bailey Meter Company Ltd., Montreal, Ca

Builders-Providence
Esterline-Angus
Foxboro Co.
Infilco, Inc.
International Filter Co.
Leupold & Stevens
Parks Co., Harry S.
Republic Flow Meters
Simplex Valve & Meter
Taylor Inst. Cos.
Uehling Inst. Co.

GAGES, Mercury

Amthor Testing Mach.
Bacharach Industrial Inst.
Bailey Meter Co.
Barton Inst. Co.
Builders-Providence
Central Scientific
Connelly Co.
Distillation Products
Dwyer Mfg. Co.
Electronic Products
Ellison Draft Gage
Gas Appliance Specialities
General Elec. Co.
Hays Corp.
Heise Bourdon Tube
Ideal Lab. Tool
King Engineering
Machlett & Son
Manning, Maxwell & Moore
Mason-Neilan Regulator
Meriam Instrument
Moeller Instrument
Parks Co., Harry S.
Precision Therm.
Refinery Supply Co.
Scientific Glass Apparatus
Scientific Instrument
Simplex Valve & Meter
Speciality Glass Co.
Stoetling Co., C. H.
Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
Trimount Instrument
Uehling Instrument Co.
U. S. Gauge Co.
Universal X-Ray Prods.
Wallace Scientific
Westinghouse Elec.

GAGES, Micrometer

American Meter Co.
Ames Co., B. C.
Amthor Testing Mach.
Axelson Mfg.
Bethlehem Apparatus Co.
Brown & Sharpe
Cadillac Gage Co.
Central Scientific Co.
Eitzen Co.
Electro Products Labs.
Elgin National Watch
Engis Equipment
Federal Products Corp.

(Continued)

Gaertner Scientific Corp.
Instrument Dev. Labs.
Lufkin Rule Co.
Miller Falls Co.
Pratt & Whitney
Precision Therm. & Inst.
Rimat Machine
Scherr Co.
Sheffield Corp.
Slocomb Co.
Starrett Co.
Stocker & Yale
Swedish Gage
Van Keuren Co.
Wilmotte, Inc.
Zeiss, Inc., Carl

GAGES, Oil (See Ga Liquid Level)

GAGES, Optical

Acme Industrial
Amer. Measuring Insts.
Bausch & Lomb
Buchele, W.
Clark & Sons
DoAll Co.
Engineers Specialty Div.
Engis Equipment
Fecker, Inc.
Gaertner Scientific Corp
Instrument Dev. Labs.
Jarrell-Ash Co.
Jones & Lamson Machin
Mann Co., W. I.
Palos Optical Co.
Perkin-Elmer Corp.
Phoenix Prec. Inst.
Ruska & Co.
Scherr Co.
Sheffield Corp.
Stocker & Yale
Zeiss, Inc., Carl

GAGES, Paint Film

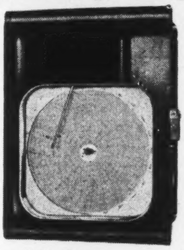
American Inst. Co.
Ames Co., B. C.
Branson Instruments
Gardner Laboratory
General Elec. Co.
Hathaway Inst. Co.
Metron Instrument
Munsell Color Co.

GAGES, Paper Thick (See Gages, Thick

GAGES, Piston Ring

Amer. Measuring Ins
Brown & Sharpe
Circle Gage Co.
Elgin National Watch
Federal Products Corp
Link Engineering
Merz Engineering
Sheffield Corp.
Swedish Gage
Wilkening Mfg. Co.

BRISTOL SERIES 500
Recording and Controlling Gauges



Bristol Series 500 Gauges are offered in a wide variety of models for recording and controlling pressure, draft, vacuum, absolute pressure, liquid level.

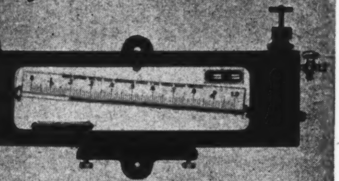
These instruments are highly accurate, dependable, rugged and extremely stable in all ranges of application. They include many design improvements and refinements that make them easier to use, more convenient to service, readily convertible from one type to another and simpler in construction. In addition, the new case offers maximum protection for the working elements and a modern design in harmony with the latest industrial trends.

Wall and panel mounting; also portable. Ranges from full vacuum to 10,000 psi. Single, double or three-pen models.

Write for Bulletins G620, G621 and G622

THE BRISTOL COMPANY
113 BRISTOL RD., WATERBURY 20, CONN.

DRAFT GAUGES



• These are extremely serviceable direct reading instruments for measuring low pressures, drafts and differentials—built with inclined tubes to give increased scale length and permit the taking of readings in fractional inches of water. Each instrument individually calibrated to assure extremely accurate operation. Oil or mercury filled tubes. Also two-tube and three-tube models for taking multiple readings with the same gauge. Fully descriptive catalog sent on request.

THE MERIAM INSTRUMENT CO.
10958 MADISON AVENUE
CLEVELAND 2, OHIO

Manometers, Meters and Gauges for the accurate measurement of Pressures, Vacuums and Flows of Liquids and Gases.

Now... NUMBER OF TANKS AND DISTANCE *Unlimited*
ACCURATE *Remote* LIQUID LEVEL GAUGING

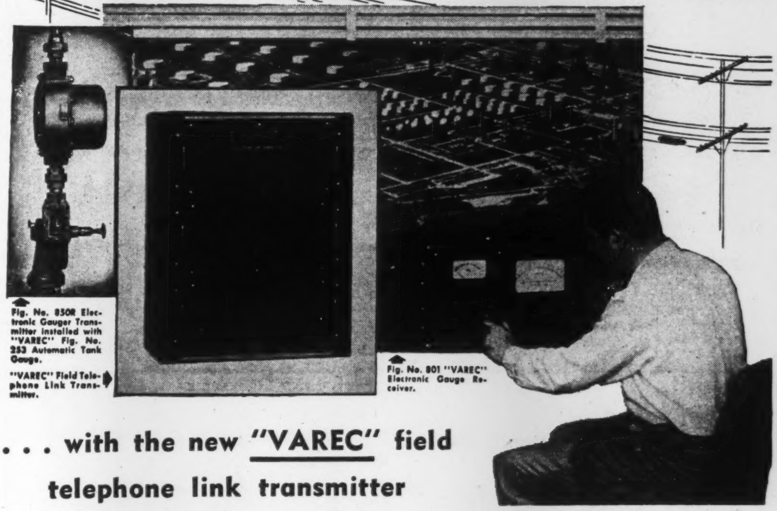


Fig. No. 850R Electronic Gauger Transmitter installed with "VAREC" Fig. No. 253 Automatic Tank Gauge.

"VAREC" Field Telephone Link Transmitter.

Fig. No. 801 "VAREC" Electronic Gauge Receiver.

. . . with the new "VAREC" field telephone link transmitter

Now, with "Varec's" unique new Field Telephone Link Transmitter, (When used in conjunction with its Electronic Gauger Receiver and Electronic Gauger Transmitter) distance factors are literally unlimited, as are the number of tanks possible to gauge from a single remote point.

At the turn of a dial switch, accurate, REMOTE liquid level gauging in oil refineries, chemical plants, pipe line pump stations and storage terminals is an important reality.

Utilization of existing telephone or power lines minimize installation and wiring costs, in addition to material savings realized in time, labor and accurate gauging with a "Varec" Electronic Gauger installation.

Now it is possible for only one gauger or operator to obtain accurate (within ⅛") continuous gauge readings from any one or a series of tanks simultaneously. The operator needs no special electronic knowledge to maintain or service the "Varec" unit as all parts are of standard plug-in design.

A complete extra service kit is included to assure continuous, dependable operation. WESTON Meter equipped. Low voltage, low current transmission only 0.001 volts D.C. at explosion-proof tank transmitter. Designed to operate from 110-115 volt, 50-60 cycle A.C. or 220 A.C. power at receiver.

There's a "Varec" Electronic REMOTE Liquid Level Gauging unit to meet your requirements. Where close control of blending operations is desired, automatic high and low valve, pump and alarm control is available. Adaptable for use with Brown Instruments, Foxboro Dynalog and Weston Instrument temperature and recording instruments for remote indications. Write for our recommendations on your gauging problems today.

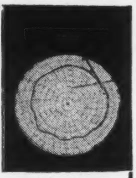
FOR ALL TYPES OF TANKS — FOR SINGLE OR MULTIPLE INSTALLATIONS • 4 TYPES OF "VAREC" EXPLOSION-PROOF TRANSMITTERS TO MEET WORKING PRESSURES UP TO 300 PSIG • ELECTRONIC OR MECHANICAL HI-LO LEVEL ALARM SYSTEMS.

WRITE DEPT. A-5

THE VAPOR RECOVERY SYSTEMS CO.
COMPTON, CALIFORNIA, U. S. A.
Cable Address: VAREC COMPTON USA (All Codes)
New York — Boston — Pittsburgh — Chicago — Detroit
St. Louis — Houston — Tulsa — Casper, Wyo. — Provo, Utah — Los Angeles — San Francisco — Seattle

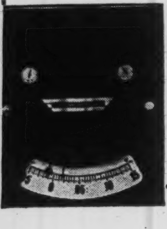
"Varec" PROVED and APPROVED

P-18



PRESSURE GAUGES

• For vacuum, pressure, absolute pressure, and compound vacuum-pressure ranges. Instruments are noted for precision engineered actuating elements which provide maximum accuracy and overload protection with minimum hysteresis effect. Indicators and Recorders furnished in a variety of air-operated and electric control forms. Send for Catalog 7000.



Also Brown Furnace Pressure Controllers for all types of furnaces, kilns, stills and other applications. Write for Bulletin 74-3.

MINNEAPOLIS-HONEYWELL REGULATOR Co., *Industrial Division*, 4579 Wayne Ave., Phila. 44, Pa.

MINNEAPOLIS
Honeywell
Brown Instruments

Manufacturers of

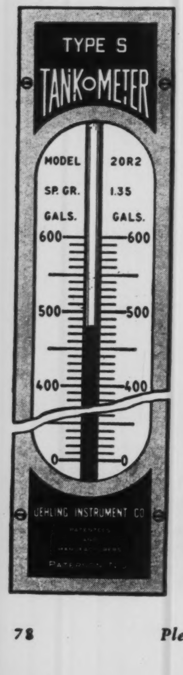
Precision Dial Pressure Gages

•

BEACON GAGE CO.

11 RIVER STREET
WELLESLEY HILLS 82, MASSACHUSETTS

UEHLING INSTRUMENT CO.



PATERSON 3, NEW JERSEY

INSTRUMENTS FOR MEASURING

PRESSURE-VACUUM-DRAFT
DIFFERENTIAL PRESSURE
BAROMETRIC PRESSURE
ABSOLUTE PRESSURE
TANK CONTENTS
DEPTH & FLOW

MEASURE AND KNOW

SEND FOR BULLETINS

GAGES, Pipe
Sheffield Corp.
Size Control Co.

GAGES, Pitch Diameter
Acme Industrial
Brown & Sharpe
Bryant Chucking Grinder
Detroit Tap & Tool
DoAll Co.
Federal Prod. Corp.
Fonda Gage Co.
Greenfield Tap & Die
Lufkin Rule Co.
Merz Engineering
Pratt & Whitney
Scherr Co., Inc.
Sheffield Corp.
Size Control Co.
Starrett Co.
Swedish Gage Co.
Union Tool Co.
Van Keuren Co.
Vinco Corp.
West & Dodge Thread
Woodworth Co.

GAGES, Plug
Acme Industrial
American Gauge Co.
Amer. Measuring Insts.
Brown & Sharpe
Cadillac Gage Co.
Corning Glass Works
Dearborn Gage Co.
Detroit Tap & Tool
DoAll Co.
Eitzen Co.
Elgin National Watch
Federal Products, Corp.
Fonda Gage
Greenfield Tap & Die
Lawrence & Hill
Merz Engineering
Nilsson Gage Co.
Park Sales Co.
Pratt & Whitney
Precision Gage & Tool
R & M Mfg. Co.
Sheffield Corp.
Size Control Co.
Standard Gage
Swedish Gage
Vinco Corp.
West & Dodge Thr. Gage
Woodworth Co.

GAGES, Pneumatic Tank
Bacharach Industrial
Barton Inst. Co.
Foxboro Co.
Liquidometer Corp.
Marsh Corp.
Mason-Neilan Regulator
Parks Co., Harry S.
Pneumercator Co.
Rochester Co.
Uehling Inst. Co.
U. S. Gauge Co.

GAGES, Precision Measuring
Acme Industrial
Aero Electronics
Ames Co., B. C.
Amer. Measuring Inst.
Arma Corporation
Barr Instrument
Bethlehem Apparatus
Brown & Sharpe
Bryant Chucking Grinder
Cadillac Gage Co.
Comtor Co.
Dearborn Gage Co.
Dice Co., J. W.
DoAll Co.
Eitzen Co.
ElginNational Watch
Engis Equipment
Federal Prod. Corp.
Ferner Co.
Fonda Gage Co.
General Elec. Co.
Graham-Mintel Inst.
Jansson Gage Co.
Lufkin Rule Co.
Magnetic Gauge Co.
Martin-Hubbard Corp.
Merz Engineering
Metron Instrument
Moore Products
Nilsson Gage Co.
Phoenix Prec. Inst.
Physicists Research
Poole Instruments
Pratt & Whitney
Rieker Instrument Co.
Rockwell Engr.
Saart, Kraemer & Hanscom
Scherr Co., Inc.
Sheffield Corp.
Size Control Co.
Standard Gage
Starrett Co.
Stocker & Yale
Swedish Gage
Thwing-Albert Inst. Co.
United Precision Prod.
Van Keuren Co.
Vinco Corp.
Webber Gage Co.
Wilmotte, Inc.
Woodworth Co.
Carl Zeiss, Inc.

GAGES, Pressure, Indicating
Acragage
Aeromarine Inst. Co.
Aeroquip Corp.
American Chain & Cable
American Meter Co.
Bacharach Industrial Ints.
Bailey Meter Co.
Baird Meter Co.
Baird Associates
Baldwin Locomotive
Bastian-Blessing

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Beacon Gage Co.
Bethlehem Apparatu
Block Mfg. Co.
Boekel & Co.
Bristol Co.
Bryant Chucking Grinder
Brush Development Co.
Builders-Providence
Central Scientific Co.
Clark Blast Meter
Cleveland Fuel Equip.
Coleman Inst. & Mfg.
Commerical Research
Consolidated Engg.
Continental Elec. Co.
Crosby Steam Gage
Dayton-Rogers Mfg. Co.
Defender Automatic Reg.
Dickson Co.
Dillon & Co.
Distillation Products
Dwyer Mfg. Co.
Eclipse-Pioneer Div.
Electric Auto-Lite
Electro-Mec Lab.
Electro Products Labs.
Electronic Products Co.
Elematic Equip. Corp.
Ellison Draft Gage
Emery Co., A. H.
Engineering Research & Dev
Esterline-Angus Co.
Fisher Scientific Co.
Foxboro Co.
Fredericks Co., George
Friez Instrument
Fulton Sylphon Div.
Gas Appliance Specialtie
General Elec. Co.
General Physical Lab.
Giannini & Co.
Gordon Co., Claud S.
Gotham Inst.
Gulton Mfg.
Hathaway Inst. Co.
Hays Corp.
Heise Bourdon Tube
H & H Thermostats
Kollsman Inst. Div.
Logansport Machine
Lonergan Co.
Magnetic Gauge Co.
Manning, Maxwell & Moore
Mansfield & Green
Marsh Corp.
Marshalltown Mfg. Co.
Mason-Neilan Regulator
Massa Laboratories
Mercoid Corp.
Meriam Instrument
Metron Instrument
Minneapolis-Honeywell
Moeller Instrument Co.
Moore Products
National Research
Nurnberg Thermometer
Pacific Div.
Parks Co., Harry S.
Perfex Corp.
Physicists Research
Podbielniak, Inc.
Precision Gage & Tool
Precision Therm.
Preferred Utilities Mfg.
Process & Instruments
RCA Div.
Refinery Supply Co.
Republic Flow Meters
Rochester Mfg. Co.
Scientific Glass App.
Scientific Inst. Co.
Seely Inst. Co., Inc.
Sheffield Corp.
Skaneateles Mfg. Co.
Statham Labs.
Stewart-Warner Corp.
Stoelting Co., C H
Stokes Machine Co
Superior Meter Co.
Surface Combustion
Sylvania Elec. Prod.
Tagliabue Div.
Taylor Inst. Cos.
Thwing-Albert Inst. Co.
Trans-Sonics, Inc.
Trerice Co.
Trimount Instrument
Uehling Instrument Co.
U. S. Gauge
Universal X-Ray Prods.
Wagner & Son, Carl H.
Wallace & Tiernan (Low Pressure)
Weksler Thermometer
Welch Scientific
Wheelco Instruments
Wiancko Engineering
Wilgus Manufacturing
Winslow Co.
Witt Gage Co.

GAGES, Pressure—Recording (See Gages, Pressure, Indicating)

GAGES, Pressure Temperature (See Gages, Pressure Indicating)

GAGES, Pressure & Vacuum (See Gages, Pressure Indicating)

GAGES, Profile
Acme Industrial
American Gage Co.
Amer. Measuring Insts.
Brush Devlopment
Cadillac Gage Co.
Dearborn Gage Co.
Engineers Specialty Div.
Federal Products Corp.
Fonda Gage
Foxboro Co.
General Elec. Go.
Jansson Gage Co.
Martin-Hubbard Corp.
Merz Engineering
Nilsson Gage Co.

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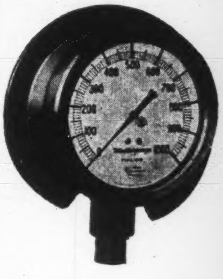
MARSH PRESSURE GAUGES

Mastergauge

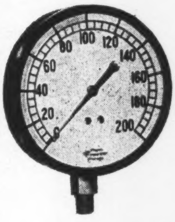


Marsh quality, stamina and accuracy, is found in its highest development in the "Mastergauge." Accuracy is guaranteed within ½ of 1% of reading. Advanced monel and stainless steel movement and rugged bourdon tube assure lasting accuracy under all conditions. Try the Mastergauge where others have failed. There is one for every service.

Only the Marsh has the Recalibrator

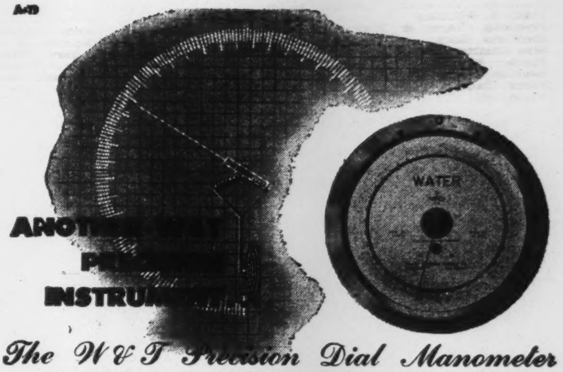
The "Recalibrator" provides the best and quickest method of correcting a gauge that has been knocked out of adjustment. It is available in all Marsh gauges.

A Gauge for Every Service



The Marsh line also includes the "quality" gauges for use under severe conditions and the "Standard" gauges for ordinary conditions. The moderately priced "Standard" gauge is illustrated opposite. From "Mastergauge" to "Standard" gauge all Marsh Gauges represent the finest obtainable for the service for which they are recommended.

JAS. P. MARSH CORPORATION
Dept. 8, Skokie, Ill.



The W&T Precision Dial Manometer

The W&T Precision Dial Manometer answers the problem of conveniently measuring pressure with a sensitivity of 1 part in 10,000.

This sturdy, compact instrument, which is widely used for wind tunnel work, power plant test stands and in gas turbine testing, has a large easy-to-read dial. It is custom calibrated in any pressure units over various ranges up to a maximum of 200 inches of mercury.

In addition, the W&T Precision Dial Manometer possesses these outstanding advantages:

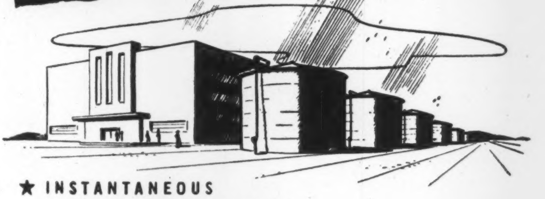
Accuracy .....1 part in 1000
Scale length ..45"
Case ... .pressure tight, metal for flush mounting.
Full protection against over pressure.
Measures gauge pressure, vacuum and differential pressure.

This instrument with its sensitive response and precision results is typical of a wide variety of pressure instruments of all types — from low pressure indicators to altimeters — manufactured by W&T. If you have a problem in pressure measurement, write, telling us the details. We'll be glad to help.

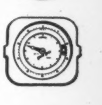
WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
Belleville 9 New Jersey • Represented in Principal Cities

Complete Control

OF TANK STOCKS



★ **INSTANTANEOUS INVENTORY READINGS!**



Now, a complete gaging system which eliminates many gaging operations. Eye-level readings at each tank, **plus** electric dials on master control panel always before your operator's eyes — ready to give readings instantly. Easy to install. Accurate. Time Saving. Send for Bulletin No. 148.

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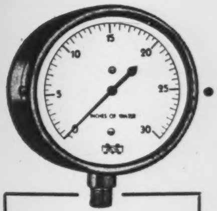
Corporation
METER DIVISION

FACTORIES: 5715 SMITHWAY ST., LOS ANGELES 22, CALIF. • P.O. BOX 500, SUCCASUNNA, N. J.

MARSHALLTOWN
LOW PRESSURE DIAPHRAGM GAUGE



Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking the low pressures.

Write for details and price.

LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15"—0-30"—0-60"—0-100"—0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled deep steel case.

MARSHALLTOWN MANUFACTURING CO.
MARSHALLTOWN, IOWA

Physicists Research
Pratt & Whitney
Precision Gage & Tool
Sheffield Corp.
Size Control Div.
Stocker & Yale
Swedish Gage Co.
Vinco Corp.
Woodworth Co.

GAGES, Radius
Acme Industrial
American Meas. Insts.
Brown & Sharpe
Cadillac Gage Co.
Dearborn Gage Co.
Federal Products Corp.
Fonda Gage Co.
Lovins Engr.
Lufkin Rule Co.
Nilsson Gage Co.
Sheffield Corp.
Size Control Co.
Starrett Co.
Stocker & Yale
Swedish Gage Co.
Vinco Corp.
Wilmotte, Inc.
Woodworth Co.

GAGES, Rain (See Rain Gages)

GAGES, Rifle Bore
Baldwin Locomotive
Federal Products Corp.
Fonda Gage Co.
Hathaway Inst. Co.
Moore Products
Nilsson Gage Co.
Poole Instruments
Pratt & Whitney
Sheffield Corp.
Vinco Corp.

GAGES, Ring
Acme Industrial
Allen Gauge & Tool Co.
American Gage Co.
Amer. Measuring Insts.
Brown & Sharpe
Bryant Chucking
Cadillac Gage Co.
Corning Glass Works
Dearborn Gage Co.
Detroit Tap & Tool
Elgin National Watch
Greenfield Tap & Die
Johnson Gage Co.
Lawrence & Hill
Merz Engineering
Nilsson Gage Co.
Park Sales Co.
Pratt & Whitney
Precision Gage & Tool
Sheffield Corp.
Size Control Co.
Standard Gage
Swedish Gage Co.
Vinco Corp.
West & Dodge Thread
Woodworth Co.
Worley Jewel Co.
Zeiss, Inc., Carl

GAGES, Screw Thread
Acme Industrial
Allen Gauge & Tool Co.
Brown & Sharpe
Bryant Chucking
Cadillac Gage Co.
Detroit Tap & Tool
Federal Prod. Corp.
Fonda Gage Co.
Greenfield Tap & Die
Jansson Gage Co.
Johnson Gage Co.
Lufkin Rule Co.
Merz Engineering
Millers Falls Co.
Pratt & Whitney
Sheffield Corp.
Size Control Co.
Starrett Co.
Swedish Gage Co.
Vinco Corp.
West & Dodge Thread
Woodworth Co.
Zeiss, Inc., Carl

GAGES, Sliding
Acme Industrial
Amer. Measuring Insts.
Barr Instrument
Lufkin Rule Co.
Pratt & Whitney
Size Control Co.
Van Keuren Co.

GAGES, Snap
Acme Industrial
Allen Gauge & Tool Co.
American Gage Co.
American Measuring Insts.
Barr Instrument
Brown & Sharpe
Cadillac Gage Co.
Dearborn Gage Co.
Detroit Tap & Tool
Federal Products Corp.
Fonda Gage Co.
Gen. Engg. & Model Wks.
Greenfield Tap & Die
Jansson Gage Co.
Johnson Gage Co.
Lawrence & Hill
Merz Engineering
Metzger & Son
Nilsson Gage Co.
Pratt & Whitney
Precision Gage & Tool
~~Seherr Co.~~
Sheffield Corp.
Size Control Co.
Standard Gage
Swedish Gage Co.
Vinco Corp.

GAGES, Spline
Acme Industrial
American Meas. Insts.
Brown & Sharpe
Federal Products Corp.
Merz Engineering
Pratt & Whitney
Precision Gage & Tool
Sheffield Corp.
Size Control Co.
Standard Gage
Vinco Corp.

GAGES, Star
Federal Products Corp.
Moore Products
Pratt & Whitney
Sheffield Corp.

GAGES, Strain
Acme Industrial
American Inst. Co.
Anderson, Arthur R.
Bailey Meter Co.
Baldwin Locomotive
Pacific Div.
Dillon & Co.
Edin Electronics
Eitzen Co.
Electronic Products Co.
Federal Products Corp.
General Elec. Co.
Giannini & Co.
Gulton Mfg.
Hathaway Inst. Co.
Hays Corp.
Heiland Research
Metzer & Son
Miller Corp., Wm.
Olsen Testing Machine
Pratt & Whitney
Reed Research
Riehle Testing Mach.
Starrett Co.
Statham Labs.

GAGES, Stream
Leupold & Stevens

GAGES, Surface
Acme Industrial
American Meas. Insts.
Ames Co., B. C.
Barr Instrument
Blake Co., Edward
Brown & Sharpe
Brush Development
Comtor Co.
Dearborn Gage Co.
Edin Electronics
Federal Products Corp.
Genales, Andrew
Jansson Gage Co.
Lufkin Rule Co.
Millers Falls Co.
Optron Laboratory
Palos Optical Co.
Physicists Research
Precision Scientific
Standard Gage
Starrett Co.
Swedish Gage
Zeiss, Inc., Carl

GAGES, Surface Finish Checking
Blake Co., Edward
General Electric
Link Eng. & Mfg.
Physicists Research
Surface Checking Gage

GAGES, Taper
Acme Industrial
American Gage Co.
Brown & Sharpe
Cadillac Gage Co.
Dearborn Gage Co.
Elgin National Watch
Federal Prod. Corp.
Fonda Gage Co.
General Electric
Greenfield Tap & Die
Lincoln Park Tool
Merz Engineering
Micro Master Co.
Moore Products
Nilsson Gage Co.
Poole Instruments
Precision Gage & Tool
Pratt & Whitney
Sheffield Corp.
Size Control Co.
Standard Gage
Starrett Co.
Swedish Gage
Vinco Corp.
Woodworth Co.

GAGES, Telescoping
Brown & Sharpe
Federal Products Corp.
Lufkin Rule Co.
Starrett Co.
Swedish Gage Co.

GAGES, Thickness
Aero Electronics
American Inst. Co.
Ames Co., B. C.
Amthor Testing Inst. Co.
Automatic Temp. Control
Branson Instruments
Brown & Sharpe
Canadian Radium
Commercial Research
Dearborn Gage Co
Dice Co., J. W.
Edin Electronics
Elgin National Watch
Federal Prod. Corp.
Fonda Gage Co.
Glogau & Co.
Gen. Engg. & Model Wks.
General Elec. Co.
Hathaway Inst. Co.
Ill. Testing Labs.
Industrial Electronics
Industrial Nucleonics
Instrument Dev. Labs.
Krouse Testing Machine
Lawrence & Hill

(Continued)

Lufkin Rule Co.
Marshall Co.
Merz Engineeringg
Metzger & Son
Millers Falls Co.
Moore Products
Photocon Research
Poole Instruments
Pratt & Whitney
Precision Gage & Tool
Precision Scientific Co.
Precision Therm. & Inst.
Saart, Kraemer & Hanscom
Scott Testers
Sheffield Corp.
Size Control Co.
Speidel & Co.
Sperry Products, Inc.
Standard Gage
Starrett Co.
Swedish Gage
Thwing-Albert Inst. Co.
Tracerlab Inc.
Van Keuren Co.
Waltham Dial Gage
Westinghouse Elec.
Woodworth Co.

GAGES, Thickness, Magnetic
Aero Electronics
American Inst. Co.
Commercial Research
Electric Eye Equip.
General Elec. Co.
Hathaway Inst. Co.
Hickok Elec. Inst. Co.
Krouse Testing Machine
Metron Instrument
Pratt & Whitney
Schaevitz Engg.
Sheffield Corp.

GAGES, Thickness, Ultrasonic
Branson Instruments, Inc.
Dice Co., J. W.
DoAll Co.
Gulton Mfg. Co.
Magneflux Corp.
Sheffield Corp.

GAGES, Thread
Acme Industrial
Bryant Checking
Fonda Gage
Johnson Gage Co.
Pratt & Whitney
Sheffield Corp.
Size Control Co.
Swedish Gage Co.

GAGES, Torque
Aero Electronics
Airdraulics Engineering
General Elec. Co.
Hagan Corp.
Hathaway Inst. Co.
Manning, Maxwell & Moore
Martin Decker Corp.
Metron Instrument
Pelouze Mfg. Co.
Riehle Div.
Schaevitz Engg.
Statham Labs.
Sturtevant Co.
Toledo Scale Co.

GAGES. Vacuum (See Gages, Pressure)

GAGES, Venturi (See Flow Meters, Venturi)

GAGES, Vibration
Electro Products Labs.
Gulton Mfg. Co.
Industrial Electronics
Panoramic Radio Products
Scott, Inc., H. H.
Sheffield Corp.
Statham Labs.
Walkirt Co.
Wiancko Engineering

GAGES, Water Level (See GAGES, Liquid Level)

GAGES, Wind
Aero Electronics
American Inst. Co.
Bacharach Ind. Inst.
Electric Speed Ind.
Friez Inst. Div.
Green, Henry J.
Hastings Inst. Co.
Illinois Testing Labs.
Instruments Corp.
Kenyon Inst. Co.
Leupold & Stevens
Rieker Inst. Co.
Stewart, M. C.
Taylor Inst. Cos.
Thomas Co., Arthur H.

GAGES, Wire Measuring
Amer. Measuring Insts.
Ames Co., B. C.
Brown & Sharpe
Elgin National Watch
Federal Prod. Corp.
Foxboro Co.
General Elec. Co.
Greenfield Tap & Die
Hathaway Inst. Co.
Merz Engineering
Moore Products
Nilsson Gage Co.
Pratt & Whitney
Sheffield Corp.
Starrett Co.
Swedish Gage Co.

GAGING FIXTURES
Acme Industrial
Amer. Measuring Insts.
Allen Gauge & Tool Co.
Daco Machine & Tool
Dearborn Gauge Co.
Eitzen Co.
Electric Eye Equip.
Elgin National Watch

(Continued)

Federal Products Corp.
Fonda Gage Co.
Jansson Gage
Lawrence & Hill
Lincoln Park Industries
Link Engineering
Merz Engineering
Saart, Kraemer & Hanscom
Ryan Tool and Engg.
Size Control Co.
Stocker & Yale
Swedish Gage
Waltham Dial Gage
Wilmotte, Inc.
Woodworth Co.

GALVANOMETERS, A-c.
Assembly Products
Associated Research
Brush Development Co.
Cambridge Inst. Co.
Central Scientific Co.
Century Geophysical
Cole Instruments
Consolidated Engg.
Dale Instruments
Edin Electronics
General Elec. Co.
General Radio Co.
Gilman Scientific
Hathaway Inst. Co.
Heiland Research Corp.
Hickok Elec. Inst.
Leeds & Northrup Co.
Metron Instrument
Pfaltz & Bauer, Inc.
Rawson Electrical Inst.
RCA Manufacturing
Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Tagliabue Div.
Welch Mfg. Co.
Weston Elec. Inst.
Wheelco Inst. Co.

GALVANOMETERS, Astatic
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Cole Instrument
Dale Instruments
Hathaway Inst. Co.
Leeds & Northrup Co.
Rawson Electrical Inst.
Ruska Instrument
Sensitive Research Inst.
Welch Scientific
Westinghouse Elec.
Wheelco Inst. Co.

GALVANOMETERS, D-c.
Assembly Products
Associated Research
Brown Inst. Div.
Brush Development Co.
Cambridge Inst. Co.
Central Scientific Co.
Century Gheophysical
Cole Instrument
Coleman Inst. & Mfg.
Consolidated Engg.
Dale Instruments
DeJur-Amsco
Edin Electronics
Edison Elec. Controls
Electric Des. & Eng.
Electronic Development
Engelhard, Charles
General Electric
Gilman Scientific
G-M Labs.
Hathaway Inst. Co.
Heiland Research
Hickok Elec. Inst.
Jarrell-Ash Co.
J-B-T Instrument Co.
Leeds & Northrup Co.
Marion Electric Inst.
Meters, Inc.
Metron Instrument
Rawson Electrical Inst.
RCA Manufacturing Co.
Roller-Smith Co.
Rubicon Co.
Sanborn Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Simpson Elec. Co.
Southwestern Ind. Elec.
Taco West Corp.
Tagliabue Div.
Thwing-Albert Inst.
Triplett Electrical Inst.
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.
Wheelco Inst. Co.
Winslow Co.

GALVANOMETERS, Reflecting
Associated Research
Brush Development
Century Geophysical
Cole Instrument
Coleman Instrument
Consolidated Engg.
General Electric Co.
G-M Laboratories
Hathaway Inst. Co.
Heiland Research
Jarrell-Ash Co.
Leeds & Northrup
Pfaltz & Bauer
Rawson Electrical Inst.
Rubicon Co.
Ruska & Co.
Sanborn Co.
Southwestern Ind. Elec.
Sprengnether Inst. Co.
Thwing-Albert Inst. Co.

GALVANOMETERS, Vacuum-tube
Beckman Insts.
Cole Instrument

(Continued)

Electronic Div. Lab.
Electro Products Lab.
Engineering Labs., Inc.
General Radio
Harvey Radio Labs.
Hathaway Instrument Co.
Heiland Research
MacDonald Co., W. S.
Measurements Corp.
RCA
Rockwell Engr.
Sanborn Co.
Tagliabue Div.
Varo Mfg. Co.

GALVANOMETERS, Vibration
Century Geophysical
Consolidated Engg.
Hathaway Inst. Co.
Leeds & Northrup

GALVANOSCOPES
Central Scientific Co.
Stoelting Co., C. H.
Welch Scientific

GAS ANALYZERS, Air
Burrell Technical Supply
Cambridge Inst. Co.
Central Scientific Co.
Cook Electric
Davis Emergency Equip.
Fish-Schurman Co.
Fisher Scientific Co.
Friez Div.
General Elec. Co.
Hays Corp.
Hebler Co.
Mercoid Corp.
Mine Safety Appliances
Perkin-Elmer Corp.
Permutit Co.
Process & Instruments
Refinery Supply Co.
Sargent & Co.
Scientific Glass App.
Tagliabue Div.
Wilson Products, Inc.

GAS ANALYZERS, Ammonia
Baird Associates
Burrell Technical Supply
Cambridge Inst.
Davis Emergency Equip.
Engelhard, Chas.
General Elec. Co.
Hays Corp.
Hebler Co.
Mercoid Corp.
Perkin-Elmer Corp.
Permutit Co.
Process & Instruments
Sargent & Co.
Tagliabue Div.

GAS ANALYZERS, Carbon Dioxide
Ace Glass, Inc.
Bacharach Industrial Inst.
Baird Associates
Burrell Tech. Supply
Cambridge Inst. Co.
Central Scientific Co.
Davis Emergency Equip.
Defender Inst. & Reg.
Dwyer Mfg. Co.
Ellison Draft Gage Co.
Engelhard, Chas.
Fish-Schurman Co.
Fisher Scientific
Friez Instrument
General Elec. Co.
Gordon Co., Claud S.
Gow-Mac Instrument
Hays Corp.
Hebler Co.
Laboratory Equip. Co.
Leeds & Northrup Co.
Liston-Folb
Machlett & Son
Mine Safety Appliances
Perkin Elmer Corp.
Permutit Co.
Podbielniak, Inc.
Potter Co.
Precision Therm.
Preferred Utilities Mfg.
Process & Instruments
Refinery Supply Co.
Republic Flow Meters
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
Uehling Instrument Co.
Victory Engr. Co.
Viking Instruments
Williams Apparatus Co.

GAS ANALYZERS, Carbon Monoxide
Bacharach Industrial Inst.
Bailey Meter Co.
Baird Associates
Burrell Technical Supply
Cambridge Inst. Co.
Central Scientific
Chicago Apparatus Co.
Davis Emergency Equip.
Eclipse Aviation
Electric Heat Control
Fish-Schurman Co.
Fisher Scientific
General Elec. Co.
Hays Corp.
Laboratory Equip. Co.
Leeds & Northrup Co.
Liston-Folb
Machlett & Son
Mine Safety Appliances
Perkin-Elmer Corp.
Podbielniak, Inc.
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
Taller & Cooper
Will Corporation

GAS ANAYZERS, Chlorinated Hydrocarbon
Baird Associates
Beckman Insts.
Consolidated Engg.
Davis Emergency Equip.
Engelhard, Chas.
General Elec. Co.
Hebler Co.
Industrial Insts. Inc.
Liston-Folb
Mine Safety Appliances
Perkin-Elmer Corp.
Podbielniak, Inc.
Precision Scientific
Wilson Products, Inc.

GAS ANALYZERS, Flue Gas (See Gas Analyzers, Carbon Dioxide or Oxygen)

GAS ANALYZERS, Hydrocarbon
Applied Physics Corp.
Bailey Meter Co.
Baird Associates
Burrell Tech. Sup.
Consolidated Eng.
Davis Emergency Equip.
Distillation Products, Inc.
Engelhard, Chas.
Fisher Scientific
General Elec. Co.
Hebler Co.
Industrial Insts. Inc.
Johnson-Williams, Ltd.
Liston-Folb
Mine Safty Appliances
National Tech. Labs.
Perkin-Elmer Corp.
Podbielniak, Inc.
Precision Scientific

GAS ANALYZERS, Hydrogen
Bacharach Industrial Inst.
Burrell Technical Supply
Chicago Apparatus Co.
Davis Emergency Equip.
Engelhard, Chas.
Fisher Scientific
General Elec. Co.
Gow-Mac Inst. Co.
Hays Corp.
Hebler Co.
Johnson-Williams, Ltd.
Leeds & Northrup
Mine Safety Appliances
Permutit Co.

GAS ANALYZERS, Hydrogen Sulphide
American Meter
Baird Associates
Burrell Technical Supply
Cambridge Inst. Co.
Connelly Co.
Consolidated Engg.
Davis Emergency Equip.
Engelhard, Chas.
Fisher Scientific
Hebler Co.
Industrial Inst. Inc.
Mine Safety Appliance
Perkin-Elmer Corp.
Rubicon Co.
Sargent & Co.
Scientific Glass Apparatu

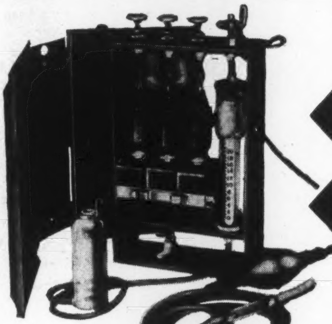
GAS ANALYZERS, Nitri Oxide
Baird Associates
Beckman, Inc., Arnold O.
Cambridge Inst. Co.
Davis Emergency Equip.
Engelhard, Chas.
Fisher Scientific
General Electric Co.
Hays Corp.
Liston-Folb
Mine Safety Appliances
Perkin-Elmer Corp.
Rubicon Co.
Sargent & Co.

GAS ANALYZERS, Orsat
Ace Glass, Inc.
Bacharach Ind. Inst.
Bailey Meter Co.
Burrell Technical Supply
Central Scientific Co.
Chicago Apparatus Co.
Defender Automatic Reg.
Dwyer Mfg. Co.
Ellison Draft Gage
Fish-Schurman Co.
Fisher Scientific Co.
Hays Corp.
Howe & French, Inc.
Laboratory Equip. Co.
Machlett & Son
Podbielniak, Inc.
Precision Therm.
Sargent & Co.
Scientific Glass App.
Specialty Glass Co.
Thomas Co., Arthur H.

GAS ANALYZERS, Oxygen
Bacharach Industrial Inst.
Bailey Meter Co.
Beckman, Inc., Arnold O.
Burrell Technical Supply
Chicago Apparatus Co.
Cambridge Inst. Co.
Davis Emergency Equip.
Eclipse Aviation
Engelhard, Charles
Hays Corp.
Hebler Co.
Laboratory Equip. Corp.
Leeds & Northrup
Mine Safety Appliances
National Tech. Labs.
Podbielniak, Inc.
Precision Scientific
Process & Instruments
Sargent & Co.
Scientific Glass App.
Superior Meter Co.
Tagliabue Div.

Analyze for CO, CO_2, O_2 with one instrument

HAYS ORSAT GAS ANALYZER



Complete—3 absorption units provide complete gas analysis for all the operating engineer's needs.

Rugged—built for continuous field use . . . strong, pressed steel construction.

Portable—contains everything you need to make a complete analysis . . . in one easy-to-carry case. Compact, yet all parts are easily accessible.

send for bulletin 49-668 for complete description of all styles.

The Hays Orsat Type Gas Analyzer is simple, fast, and employs the most reliable method known for obtaining accurate measurement. Available in one, two or three-unit styles (illustrated).

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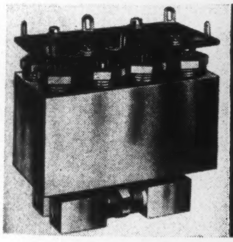
MICHIGAN CITY 8A, INDIANA
combustion and industrial instruments and control

NEW DESIGNS PERFORMANCE APPLICATIONS

In

GAS INSTRUMENTATION



8 Filament
High Output
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THERMAL CONDUCTIVITY UNITS

—for accuracy, simplicity, speed of response and economy

The practical answer to problems of continuous gas observation involving purity, quantitative change, absorption and other laboratory and process applications. Gow-Mac Sensing Elements are standard equipment in government bureaus, armed service projects, industrial and university research laboratories. Inquiries on specific gas analysis problems will receive prompt attention: no obligation.

***WRITE*, today, for new illustrated Gow-Mac 1951 Catalog**

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22 LAWRENCE STREET, NEWARK 5, NEW JERSEY

An important advancement in chemical analysis instrumentation

BECKMAN OXYGEN ANALYZERS

Indicating and Recording

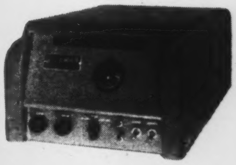
Based on the unique *paramagnetic property* of Oxygen

Features

- **High accuracy and sensitivity**
- **Simple to operate**
- **A physical measurement, not a chemical analysis**
- **Rapid response**
- **Small sample rate (50 to 250cc per minute)**
- **Flow rate independent**
- **Rugged construction**
- **Many ranges available**

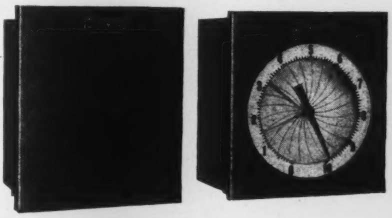
Model E-2 Beckman Oxygen Analyzers

Accuracies of ±0.005% O_2 attainable with these multi-range instruments. Samples as small as 10 cc readily analyzed. Highest precision portable laboratory oxygen analyzer. Operates on 115 volts, 50/60 cycle.



Model G-2 Beckman Oxygen Analyzers

Full scale ranges from 200 ppm to 100% O_2 available in this self-balancing, recorder-controller analyzer. Accuracies up to ±0.001% O_2 (depending upon range). Self-stanardizing available for automatic compensation of electrical, thermal, background gas, and barometric pressure variations. Ideal for precise process control.



Model C Beckman Oxygen Analyzers

Direct reading, single range, general purpose, portable oxygen analyzer. Factory calibration and electrical thermostating provide high accuracy— ±1% of full scale. Minimum range 0-40 mm oxygen partial pressure (0-5% O_2). Widely used for medical studies, scientific research, and industrial analyses. Operates on 115 volts 50/60 cycle.

Other models also available. Send for complete descriptive literature. Our engineering department will gladly make recommendations concerning special applications of our instruments.

ARNOLD O
BECKMAN
INC.
OXYGEN ANALYZER

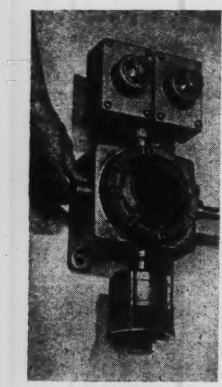
1020 MISSION STREET · SOUTH PASADENA, CALIFORNIA

DETECT combustible GAS

INDICATE • RECORD • CONTROL

J-W Model F Indicator checks the presence of combustible gas at inaccessible locations. Aspirator bulb draws air mixture through sampling hose and probe. Meter registers combustibility instantly. Fully portable, dry-cell operated.

MODEL F



MODEL EE

J-W Models E and EE Alarms monitor fixed installations where explosive hazards may exist. For continuous operation from standard 115-v a-c line. Actuate audible or visual signals, control valves or motors. Model EE is explosion proof. Model E is for installation remote from sensing unit.

J-W Sentinel Alarm serves as a fire-danger watch-dog under conditions of special localized combustible-gas hazard—such as: welding, electrical work, tank cleaning, etc. Storage-battery operated, inbuilt charger, penetrating audible alarm.

SENTINEL

Other models available for laboratory, oil-well logging, and other specialized uses. Your inquiry is invited on designs to meet particular requirements.

Standard for over 25 years

JOHNSON-WILLIAMS LTD.
PALO ALTO · CALIFORNIA
2671-A THIRD STREET

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Bailey Meter Co.
Boekel & Co.
Burrell Technical Supply
Cambridge Inst. Co.
Central Scientific Co.
Davis Emergency Equip.
Fisher Scientific
Hays Corp.
Hebler Co.
Laboratory Equip. Co.
Leeds & Northrup
Mine Safety App. Co.
Podbielniak, Inc.
Precision Scientific
Process & Instruments
Sargent & Co.
Scientific Glass App.
Tagliabue Div.

GAS ANALYZERS, Sulphur Dioxide
Bacharach Industrial Inst.
Baird Associates
Burrell Tech. Sup.
Cambridge Inst. Co.
Davis Emergency Equip.
Engelhard, Chas.
Fish-Schurman Co.
Hays Corp.
Hebler Co.
Laboratory Equip. Co.
Leeds & Northrup Co.
Perkin-Elmer Corp.
Precision Scientific
Sargent & Co.
Scientific Glass App.
Skaneateles Mfg. Co.
Uehling Instrument Co.

GAS APPARATUS, Orifice Well Tester
Refinery Supply Co.

GAS DENSITY METERS
American Meter Co.
Central Scientific Co.
Ess Inst. Co.
Hagan Corp.
Permutit Co.
Precision Therm.
Refinery Supply Co.
Thomas Co., Arthur H.

GAS FLOW INDICATORS
Airflow Instrument
American Meter Co.
Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bristol Co.
Brooks Rotameter
Builders-Providence
Commercial Research
Fisher & Porter
Fish-Schurman Co.
Foxboro Co.
Hagan Corp.
Hays Corp.
Mason-Neilan Regulator
Meriam Co.
National Inst. Labs.
Phoenix Prec. Inst.
Precision Scientific Co.
Republic Flow Meters
Schutte & Koerting
Selas Company
Simplex Valve & Meter
Statham Labs.
Taylor Inst. Cos.
Victory Engr. Co.

GAS HOLDER POSITION INDICATORS
Bailey Meter Co.
Bristol Co.
Electric Indicator Corp.
Elec. Tachometer Corp.
Foxboro Co.
Hagan Corp.
Republic Flow Meters
Zuhr, Inc., Henry

GAS LEAK INDICATORS
Aircraft Electronics
Baird Associates
Bullard Co.
Consolidated Engg.
Darley Co., W. S.
Davis Emergency Equip.
Detectron
Distillation Products
Fischer & Porter
Fisher Res. Lab.
Foxboro Co.
General Elec. Co.
Gilmore, E. R.
Globe Phone Mfg. Co.
Goldak Co.
Heiland Research Corp.
Johnson-Williams, Ltd.
Kahl Scientific Inst.
Mine Safety Appliances
Moore Products
Municipal Inst.
National Research
Skaneateles Mfg. Co.
Taylor Inst. Cos.
Vacuum Electronics
Victory Engr.
Water Leak Detector Co.

GAS METERS, INFERENTIAL—Area (See Flowmeters, Area)

GAS METERS, INFERENTIAL—Flow Nozzle (See Flowmeters, Orifice and Nozzle)

GAS METERS, INFERENTIAL—Orifice (See Flowmeters, Orifice and Nozzle)

GAS METERS, INFERENTIAL—Pitot-tube (See Flowmeters, Pitot-tube)

GAS METERS, INFERENTIAL—Venturi (See Flowmeters, Venturi)

GAS METERS, POSITIVE, Bellows, Slide-valve
American Meter Co.
Bristol Co.
Littelfuse Inc.
Sprague Meter Co.
Superior Meter Co.

GAS METERS, POSITIVE, Rotary
Revere Co.
Superior Meter Co.

GAS METERS, POSITIVE, Special for extremely small flows
American Meter Co.
Brooks Rotameter
Detroit Air Meter Co.
Superior Meter Co.

GAS METERS, POSITIVE, Wet-drum
American Meter Co.
Precision Scientific Co.
Superior Meter Co.

GAS & VAPOR DISCHARGE TUBES, Argon
Amglo Corp.
Continental Electric
DuMont Labs., Inc., A. B.
Eclipse-Pioneer
General Electric
General Physical Lab.
Jarrell-Ash Co.
Morgan Instrument
Raytheon Mfg.
Skaneateles Mfg.
Sylvania Elec. Prod.

GAS & VAPOR DISCHARGE TUBES, Carbon Dioxide
Fredericks, George
Friez Instruments
General Electric
General Physical Lab.
Hanovia Chem. & Mfg.
Jarrell-Ash Co.
Skaneateles Mfg. Co.

GAS & VAPOR DISCHARGE TUBES, Hydrogen
Baird Associates
General Physical Lab.
Hanovia Chem. & Mfg.
Jarrell-Ash Co.
Skaneateles Mfg. Co.
Sylvania Elec. Prod.

GAS & VAPOR DISCHARGE TUBES, Mercury
American Inst. Co.
Amglo Corp.
Bausch & Lomb
Central Scientific Co.
Continental Electric Co.
Electronic Products
Fish-Schurman Co.
Fredericks, George
Gaertner Scientific
Gen. Elec. Lamp Dept.
General Physical Lab.
Hanovia Chem. & Mfg.
Jarrell-Ash Co.
Leitz, Inc.
Machlett & Son
Menlo Research Lab.
Mico Instrument
Pfaltz & Bauer
Precise Measurements
Raytheon Mfg.
Skaneateles Mfg. Co.
Universal X-Ray Prods.

GAS & VAPOR DISCHARGE TUBES, Neon
Amglo Corp.
Central Scientific Co.
Continental Electric
Eclipse-Pioneer
Electronic Products
Fredericks, George
Gen. Elec. Co.
General Physical Lab.
Jarrell-Ash Co.
Machlett & Son
Morgan Instrument
Skaneateles Mfg. Co.
Universal X-Ray Prods.

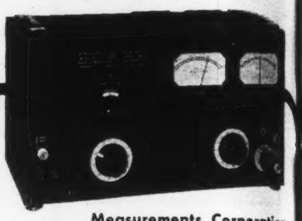
GAS & VAPOR DISCHARGE TUBES, Nitrogen
Central Scientific Co.
Electronic Products
Fredericks, George
General Physical Lab.
Skaneateles Products

GAS & VAPOR DICHARGE TUBES, Sodium
Central Scientific Co.
Fredericks, George
Gaertner Scientific Corp.
Gen. Elec. Co.
General Physical Lab.
Jarrell-Ash Co.
Leitz, Inc.
Pfaltz & Bauer, Inc.
Skaneateles Mfg. Co.
Zeiss, Inc., Carl

GASOLINE MILEAGE TESTER (For automobile and trucks) (See Meters, Mileage)

GAUGES see Gages

GAUSSMETERS
Electro-Tech Equipment
Laboratory for Electronics
Sensitive Research



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BOONTON NEW JERSEY

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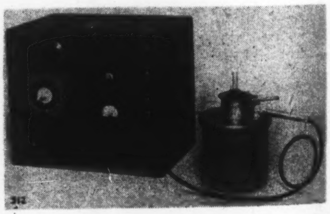

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GEIGER-MULLER COUNTERS, (See Counter, Geiger-Muller)

GEIGER-MULLER TUBES (See Counter, Geiger-Mueller)

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Columbia Elec. Mfg.
Eclipse Pioneer
Elcor, Inc.
Electric Indicator
Electronic Instrument
Georator Corp.
Hewlett-Packard
Holtzer-Cabot
Servo Corp.

GENERATORS, Complex Wave
Berkshire Laboratories
Marconi Insts., Ltd.

GENERATORS, D-c.
Columbia Elec. Mfg.
Eclipse Pioneer
Electric Indicator
Electronic Instrument
Georator Corp.
Globe Industries
Gothard Mfg.
Holtzer-Cabot
Servo Tek Products

GENERATORS, Pulse
Berkeley Scientific
Berkshire Laboratories
Cole Instrument
Electronic Instrument
Empire Devices, Inc.
Feiler Engineering
General Radio
Hewlett-Packard
Kay Electric Co.
Lavoie Labs.
Marconi Insts., Ltd.
Measurements Corp.
Potter Instrument Co.
Rutherford Electronics

GENERATORS, SIGNAL
Aircraft Radio Corp.
American Time Prods.
Automatic Elec. Chicago

(Continued)

Boonton Radio Corp.
Borden Engineering
Browning Labs.
Burke Electric Co.
Clarke Inst. Corp.
Cardwell Mfg. Co.
Clough-Brengle Co.
Collins Radio Co.
Control Corp
Crystal Research Labs.
Communication Meas. Lab.
Electric Indicator Co.
Electro Engrg. Products
Electronic Instruments
Espey Mfg.
Federal Telephone
Ferris Inst. Corp.
General Elec. Co.
General Radio Co.
General Test Equip.
Harvey Radio Labs.
Hewlett-Packard
Hickok Elect. Inst.
Jackson Electrical Inst.
Kay Electric
Kellogg Switchboard
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Measurements Corp.
Millen Mfg. Co.
National Co.
Phillips Petroleum
Precision Apparatus Co.
Premier Crystal Lab.
Radio City Products Co.
RCA Div.
Rollin Co.
Sherron Metallic
Simpson Electric
Sperry Gyroscope Co.
Sylvania Elec. Prod.
Televiso Co.
Triplett Electrical Inst.
United Electronics
Walkirt Co.

GENERATORS, Square Wave
Berkshire Laboratories
Borden Engineering
Browning Laboratories
Electro-Mechanical Res.
Electronic Instrument
Empire Devices, Inc.
Feiler Engineering
Hewlett-Packard
Kay Electric Co.
Marconi Insts. Ltd.
Measurements Corp.
Potter Instrument
Servo Corp.
Tektronix, Inc.
Triumph Mfg.
Walkirt Co.

GENERATORS, Sweep Frequency Signal
Browning Laboratories
Clarkstan Corp.
Electronic Instrument
Feiler Engineering
Kay Electric Co.
Laboratory for Electronics
Marconi Inst., Ltd.
Polytechnic Res. & Dev.
Precision Apparatus Co.
Radioactive Products

GENERATORS, Sweep Frequency Audio
Audio Tone Oscillator
Clough-Brengle
Kay Electric
Marconi Insts., Ltd.
Panaramic Radio Products
Radioactive Products

GENERATORS, Synchro
Doelcam Corp.
Ford Instrument
Sperry Gyroscope

GENERATORS, Ultrasonic
Engineering Res. & Dev.
General Electric
Gen. Precision Lab.
General Radio
Gulton Mfg. Co.
Hewlett-Packard
Kay Electric Co.
Scott Inc., H. H.
Ultrasonic Engr. Co.

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Century Geophysical
Geophysical Instrument Co.
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Globe Phone Mfg. Co.
Hathaway Inst. Co.
Heiland Research Corp.
Massa Laboratories
Southwestern Ind. Elec.
Varo Mfg. Co.

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American Inst. Co.
Associated Research
Berkeley Instruments
Borden Engineering
Brown Geophysical
Brush Development Co.
Cambridge Inst. Co.
Century Geophysical
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Electro-Mechanical Research
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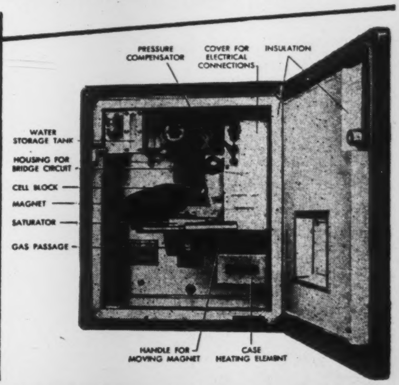

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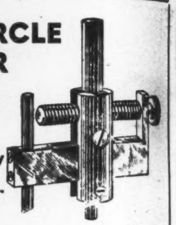

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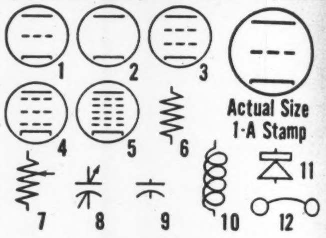
5	Round shank	6 inch	7.50
10	Round shank	14 inch	15.00



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Metron Instrument
Mico Instrument Co.
Potter Instrument
Radiation Counter Labs.
Ruska Inst. Corp.
Sensitive Research Inst.
Southwestern Ind. Elec.
Stratex Instrument Co.
Televiso Co.
Trimount Inst. Co.

GEOPHYSICAL INSTRUMENTS, Gravity Meters
Atlas Exploration Co.
Brown Geophysical
Century Geophysical
Heiland Research Corp.
Hickok Electrical Inst.
Houston Technical Lab.
National Co.
Potter Instrument
Ruska & Co.

GEOPHYSICAL INSTRUMENTS, Radioactivity
Detectron Co.
Douglas Radio Labs.
Georator Corp.
Gulton Mfg. Co.
Midwestern Geophysical
Nuclear Development Lab.
Nuclear Research & Dev.
Nucleonic Corp.
Radiation Counter Labs.
R-C Scientific Inst.
Special Instruments Lab.
Stratex Instrument Co.
Western Radiation Lab.

GILLMORE NEEDLES (See Needles, Gillmore)

GLARE METERS (See Gloss Meters)

GLASS, Low Reflecting Surfaces
Bausch & Lomb
Boehmke Optical Co.
Crystal Research Labs.
Dearborn Scientific
Distillation Products
E & S Optical
Fish-Schurman Corp.
Gaertner Scientific
National Research Corp.
Palos Optical Co.
Plummer & Kershaw
Simpson Optical Mfg.
Unertl Optical Co.
Univis Lens Co.

GLASS STRAIN TESTERS (See Testers, Glass Strain)

GLASS TUBING, Heat Resisting
Corning Glass Works
Crystal Glass Tube
Electronic Products
Fish-Schurman Co.
Jerguson Gage & Valve
Kimble Glass Co.
Phoenix Precision Inst.
Porter, George K.
Uhrig Co., Joseph F.

GLASS TUBING, Precision Bore (see Precision—bore Glass Tubing)

GLASS TUBING, Ultra-Violet Transmitting
Continental Electric
Corning Glass Works
Fish-Schurman Co.
General Elec. Co.
Phoenix Precision Inst.
Sampson Chem. & Pigment
Ultra-Violet Products

GLASS TUBING, Ultra-Violet Transmitting Opaque to Visible Lighting
Corning Glass Works
Fish-Schurman Co.
General Elec. Co.
Phoenix Precision Inst.
Sampson Chem. & Pigment

GLASSWARE, LABORATORY (See Apparatus, Laboratory, Glass)

GLOSS METERS
American Inst. Co.
Bausch & Lomb Opt.
Central Scientific Co.
Dearborn Scientific
Gardner Laboratory
Instrument Dev. Labs.
Pfaltz & Bauer, Inc.
Photovolt Corp.
Sensitive Research Inst.
Zeiss, Inc., Carl

GONIOMETERS
American Inst. Co.
American Optical
Automatic Temp. Control
Dearborn Scientific
Dusenbery Co.
Ferner Co.
Gaertner Scientific
Gardner Laboratory
General Elec. X-Ray Dept.
Hayes Scientific App.
Jarrell-Ash Co.
RCA Div.
Stocker & Yale
Stratex Instrument Co.
Zeiss, Inc., Carl

GOVERNORS (See also object of measurement and control)

GOVERNORS, Air (See Regulators, Automatic, Air)

GOVERNORS, District
American Meter Co.
Fisher Governor
Foster Engineering
General Controls
Hammel-Dahl Co.

GOVERNORS, Engine
Cash Co.
Fisher Governor
General Controls
General Elec. Co.
Hagan Corp.
Mason-Neilan Regulator
Pickering Governor
Robinette Co., W. C.
Synchro-Start Products

GOVERNORS, Gas (See Regulators, Automatic, Air)

GOVERNORS, Hydraulic
Allis-Chalmers
Cash Co.
Foster Engineering
General Controls
Hagan Corp.
Hammel-Dahl Co.
Mason Neilan Regulator
Milwaukee Prec. Instr.
McAlear Mfg. Co.
Schade Valve Mfg.
Tagliabue Div.

GOVERNORS, Liquid Level (See Controllers, Automatic, Liquid Level)

GOVERNORS, Pressure (See Regulators, Automatic, Air)

GOVERNORS, Pump (See Regulators, Automatic, Air)

GOVERNORS, Station
American Meter Co.
Fisher Governor

GOVERNORS, Steam (See Regulators, Automatic, Air)

GOVERNORS, Turbine
Allis-Chalmers
Askania Regulator Co.
Cash Co.
Foster Engineering
General Elec. Co.
Hagan Corp.
Kieley & Mueller
Mason-Neilan Regulator
Robinnette Co., W. C.
Shallcross Controls

GRADUATING MACHINES (See Dividing Machines)

GRAIN TESTERS (See Testers, Grain)

GRANULAR MATERIALS MEASUREMENTS, Level Indicator & Control
Askania Regulator Co.
Bin-Dicator Co.

GRANULAR MATERIALS MEASUREMENTS, Particle Size Separator
American Inst. Co.
Fed. Pneumatic Systems
Gump Co., B.F.
Precision Scientific

GRANULAR MATERIALS MEASUREMENTS, Volume-Flow Indicators
Builders-Providence
Dietert Co.
Richardson Scale Co.

GRANULAR MATERIALS MEASUREMENTS, Volume Integrating Meters
Bailey Meter Co.
Richardson Scale Co.

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Builders-Providence
Merrick Scale Co.
Omega Machine
Richardson Scale Co.

GRANULAR MATERIALS MEASUREMENTS, Weight-Integrating Meters
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Builders-Providence
Merrick Scale Co.
Omega Machine
Proportioneers, Inc.
Richardson Scale Co.
Toledo Scale Co.

GRAPHIC (See object of measurement and control)

GRATING, Diffraction
Applied Research Labs.
Baird Associates
Central Scientific Co.
Coleman Instruments
Dearborn Scientific
Dietert Co.
Fish-Schurman Co.
Gaertner Scientific Corp.
G. M. Mfg. Co.
Jarrell-Ash
Laboratory Specialties
Perkin-Elmer Corp.
Welch Scientific

GRATING, Echelon
Baird Associates
Gaertner-Scientific Corp.
Jarrell-Ash Co.
Palos Optical Co.

GRAVIMETERS
Atlas Exploration Co.
Brown Geophysical
Century Geophysical
Geophysical Inst. Co.
Heiland Research
Mott-Smith Corp.
Western Geophysical

GRAVITOMETERS
American Meter Co.
Fisher Scientific
Hagan Corp.
Permutit Co.
Poole Instruments
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GRAVITY, Indicators & Recorders
American Meter Co.
Bailey Meter Co.
Baird Associates
Bristol Co.
Builders-Providence
Century Geophysical
Fielden Instrument
Fischer & Porter
Foxboro Co.
G. M. Mfg.
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Precision Scientific
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Refinery Supply
Republic Flow Meters
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Specialty Glass Co.
Schultheis Corp.
Schutte & Koerting
Scientific Instrument
Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
Wallace & Tiernan

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Fish-Schurman Co.
Fisher Scientific Co.
General Electric Co.
Humboldt Mfg. Co.
Koehler Instrument
Precision Scientific Co.
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Heiland Research
Roller-Smith Co.
Westinghouse Elec.

GROUND RESISTANCE METERS
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Associated Research
Biddle Co., Jas. G.
Borden Engineering
General Elec. Co.
Geophysical Inst. Co.
Gray Instrument
Heiland Research Corp.
Industrial Inst. Inc.
Roller-Smith Co.
Shallcross Mfg. Co.
Sticht Co.

GYRO STABILIZERS
Arma Corp.
Doelcam Corp.
General Electric Co.
Summers Gyroscope
Vectron, Inc.

GYROS, Verticle and directional
Doelcam Corp.
Eclipse-Pioneer
Federal Products
Ford Instrument
Giannini & Co.
Schwien Engr.
Sperry Gyroscope
Vectron, Inc.

HARDNESS METER, for Plastic Films (See Testers, Hardness of Plastic Films)

HARDNESS TESTER (See Testers & Testing Machines, Hardness)

HARMONIC ANALYZERS
Electronic Associates
Freed Transformer
Gaertner Scientific Corp.
General Electric Co.
General Radio Co.
Hewlett-Packard
Kay Electric Co.
Keuffel & Esser Co.
Mico Instrument Co.
Scientific Apparatus Co.
United Transformer Corp.

HELIOSTATS
Eastern Science Co.
Fecker, Inc.
Gaertner Scientific Corp.

HIGH ALTITUDE TEST & CALIBRATION CHAMBERS see Chambers, Test & Calibration

HIGH-FREQUENCY APPARATUS
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Clough-Brengle Co.
Collins Radio Co.
Crystal Research Labs.
Electro Engrg. Products
Electro-Mechanical Research
Electronic Dev. Lab.
Empire Devices, Inc.
Federal Telephone Co.
Ferris Inst. Corp.
General Elec. Co.
General Radio
Harvey Radio Labs
International Resistance

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Lear, Inc.
M. B. Mfg. Co.
McFarlin Co.
Measurements Corp.
Minnesota Electronics
National Co.
Radio Receptor Co.
Raytheon Mfg. Co.
RCA Div.
Servo Corp. of America
Sheffield Corp.
Sherron Metallic
Sperry Gyroscope Co.
Sylvan Electronics Labs.
Thordarson Elec. Mfg.
Walkirt Co.
West Coast Electronics

HOOK GAGES (See Gages, Hook)

HORIZONS, ARTIFICIAL (See Artificial Horizons)

HOUR COUNTERS (See Meters, Time)

HOUSINGS, Weatherproof, Instrument
Falstrom Co.
Gilbert & Barker
Lewyt Metal Prods.
Moran Furnace

HUMIDISTATS
Automatic Products Co.
Barber-Colman
Friez Instruments
Johnson Service Co.
Minneapolis-Honeywell
Powers Regulator Co.
Sampsel Time Control
Taylor Instrument Cos.

HUMIDITY INSTRUMENTS, Aspiration (See Psychrometers, Aspiration)

HUMIDITY INSTRUMENTS, Conductivimetric
Friez Inst. Div.
Industrial Insts. Inc.
Leeds & Northrup Co.
Serdex, Inc.

HUMIDITY INSTRUMENTS, Hygrometric (See Hydrometers)

HUMIDITY INSTRUMENTS, Hygroscopic
American Inst. Co.
Barber Colman
Bristol Co.
Foxboro Co.
Friez Instrument
Johnson Service Co.

(Continued)

Powers Regulator
Serdex, Inc.
Taylor Inst. Cos.

HUMIDITY INSTRUMENTS, Sling Psychrometric (See Psychrometers, Sling)

HUMIDITY, Relative, Indicating Recorders
Alden Products
American Inst. Co.
Automatic Temp. Control
Bristol Co.
Food Technology, Inc.
Friez Instrument
Gotham Instrument
Green, Henry J.
Leeds & Northrup
Kahl Scientific Inst.
Manning, Maxwell, Moore
Minneapolis-Honeywell
Powers Regulator
Serdex, Inc.
Tagliabue Div.
Taylor Inst. Cos.
Weston Elec. Inst.

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Bailey Meter Co.
Beckman Instruments
Bristol Co.
Cambridge Inst. Co.
Central Scientific Co.
Coleman Instruments
Connelly, Inc.
Fisher Scientific Co.
Foxboro Co.
Gamma Inst. Co.
General Elec. Co.
Gray Instrument
Hellige, Inc.
Hickok Elec. Inst.
LaMotte Chemical Prod.
Leeds & Northrup Co.
Leitz, Inc.
Macbeth Corp.
Machlett & Son
Minneapolis-Honeywell
Pfaltz & Bauer, Inc.
Photovolt Corp.
Precision Scientific
Rascher & Betzold
Rawson Elec. Inst. Co.
Rubicon Co.
Sargent & Co.
Tagliabue Div.
Taylor & Co., W. A.
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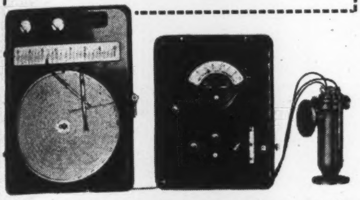
DEPENDABLE...

BRISTOL
pH Recorders
and Controllers

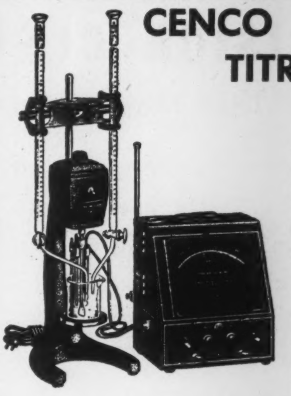


Bristol pH Recorders and Controllers are instruments of rugged construction and practical design, and have wide use in industrial processes and sewage and waterworks utilities. The control of pH minimizes corrosion difficulties, decreases maintenance costs and eliminates the possibility of contamination of water supplies from plant waste disposal.

Bristol pH Equipment consists of the following:
1. pH Recorder or Indicator—either type furnished with air-operated or electrically-operated control features—available in the round chart model, shown above, or the strip chart model.
2. Beckman pH Amplifier
3. Electrode Assembly

Write for Bulletin pH1302.

THE BRISTOL COMPANY
113 BRISTOL RD., WATERBURY 20, CONN.



CENCO
TITRATION-ph
TEST UNIT

is suitable for precise control of neutralizations, oxidation-reduction reactions and precipitations. May be used for electrometric measurement of pH values of aqueous or partly non-aqueous solutions; tests for neutralization value of petroleum products (A.S.T.M. Method D664-49); chemical analysis of inorganic alkaline detergents; tests for industrial wastes; and determining the saponification number of petroleum products (A.S.T.M. Method D939-50)

The Complete Titration Unit—consists of No. 20945 Titration Stand Assembly; No. 20965A Titration-pH Meter; No. 21106 Glass and 21144 Calomel Electrodes with 30-inch leads; and a set of No. 15938 Paired Burettes.

The Cenco Titration Unit is suggested in ferrous analyses for arsenic, chromium, copper, manganese, nickel, nitrogen, phosphorous, selenium, sulfur, tin and vanadium. Aluminum may be studied for content of calcium, chromium, copper, iron, magnesium, manganese and tin. Other non-ferrous metals may also be tested.

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National Tech. Labs.
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Podbielniak, Inc.
Precision Scientific

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Accuracy Scientific Inst.
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Fisher Scientific Co.
Fleischhauer & Son
Freas Glass Works
Fried & Lustig
G. M. Mfg. Co., Inc.
Gotham Inst. Co.
Griebel Co.
H-B Inst. Co.
Hiergesell & Sons
Huddleston, J. S. F.
Kahl Scientific Inst.
Kessler Co., Walter H.
Kimble Glass
Mason-Neilan Regulator
Moeller Instrument Co.
Nurnberg Therm. Co.
Phila. Thermometer Co.
Precision Thermometer
Rascher & Betzold
Refinery Supply
Ruehfel Co.
Ruttco Mfg. Co.
Schultheis Corp., E. W.
Scientific Glass Apparatus
Scientific Inst. Co.
Tagliabue Div.
Taylor Inst. Cos.
Testrite Instrument Co.
Trerice Co.
Wagner & Son, Carl H.
Weksler Thermometer

HYDROMETERS, Mud
Braun Corp.
Freas Glass Works
H-B Instrument
Hiergesell & Sons
Kessler Co., Walter H.
Moeller Inst. Co.
Wagner & Son

HYDROMETERS, Recording
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Hiegersell & Sons
Kessler Co., Walter H.
Mason-Neilan Regulator
Norcross Corp.
Precision Thermometer
Rascher & Betzold
Ruehfel Co.

(Continued)

Scientific Inst. Co.
Testrite Instrument Co.
Weksler Thermometer

HYDROMETERS, Thermo (See Hydrometers, Indicating)

HYGROMETERS, Controlling
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Bristol Co.
Ess Instrument
Foxboro Co.
Gordon Co., Claud S.
Gotham Inst. Co.
Green, Henry J.
Minneapolis-Honeywell
Moeller Inst. Co.
Powers Regulator
Scientific Inst. Co.
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Tagliabue Div.
Taylor Inst. Co.
Trerice Co., H. O.

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Bristol Co.
Cambridge Inst. Co.
Central Scientific Co.
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Foxboro Co.
Friez Instruments
Glogau & Co.
G. M. Mfg. Co., Inc.
Green, Henry J.
Griebel Co.
Hiergesell & Sons
Huddleston, J. S. F.
Illinois Testing Labs.
Instruments Corp.
Johnson Service Co.
Kahl Scientific Inst.
Mason-Neilan Regulator
Minneapolis-Honeywell
Moeller Instrument Co.
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Phila. Thermometer Co.
Precision Thermometer
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Sargent & Co.
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Serdex, Inc.
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Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
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HYGROMETERS, Recording
American Inst. Co.
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Cambridge Inst. Co.
Foxboro Co.
Friez Instrument Div.
General Elec. Co.
Gotham Instrument
Green, Henry J..
Instruments Corp.
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Manning, Maxwell & Moore
Mason-Neilan Regulator
Minneapolis-Honeywell
Moeller Instrument Co.
Palmer Thermometer
Powers Regulator
Scientific Inst. Co.
Seedburo Equip. Co.
Serdex Inc.
Tagliabue Div.
Taylor Inst. Cos.
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Barber-Colman Co.
Central Scientific Co.
Friez Instrument Div.
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Powers Regulator Co.
Taylor Instrument Cos.

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Central Scientific Co.
Foxboro Co.
Friez Instruments
Green, Henry J.
Instruments Corp.
Manning, Maxwell & Moore
Serdex, Inc.
Taylor Inst. Cos.

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General Elec. Co.
G. M. Mfg. Co.
Kahl Scientific Inst.
Keuffel & Esser Co.
Lufkin Rule Co.
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Kolsman Inst. Co.
Manning, Maxwell & Moore
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Electronic Prods. Co.
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Leeds & Northrup Co.
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Meters Inc
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Brush Development
Electro-Tech Equip. Co.
Esterline-Angus Co.
Friez Instruments
General Elec. Co.
Rockwell Engr.

ILLUMINOMETERS, Macbeth
Leeds & Northrup

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Michrochemical Service
Sheffield Corp.

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Precision Thermometer
Ricker Instrument
Trimount Inst. Co.

INCLINOMETERS,
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Eclipse-Pioneer Div.
Ferner Co.
Fischer & Porter
Fish-Schurman Co.
Kollsman Inst. Co.
Machlett & Son
Meriam Instrument
Rieker Inst. Co.
Precision Therm.
Ruehfel Co.
Schwein Engineering
Starrett Co.
Summers Gyroscope
Tejax Eng. Corp.
Trimount Inst. Co.
Warren-Knight Co.

INCLINOMETERS, Bore Hole
Sperry-Sun Well Surveying

INCLINOMETERS, Lateral (Aviation)
Aeromarine Inst. Co.
Eclipse-Pioneer Div.
Machlett & Son
Rieker Instrument
Schwien Engineering

INCLINOMETERS, Ship
Manning, Maxwell & Moore
Moeller Inst. Co.
Negus, T. S. & J. D.
Rieker Instrument

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Century Geophysical
Electro Products Labs.
Engineering Res. & Dev.
Photocon Research
Rowe Engineering
Rutishauser Corp.
Sperry Gyroscope
Trimount Inst. Co.

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Eclipse-Pioneer Div.
Electronic Associates
Kollsman Instrument
Lear, Inc.
Polarad Electronics
RCA Div.
Schwien Engg. Co.
Servo Corp. of America
Sperry Gyroscope Co.

INDICATORS, Engine
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Aeromarine Inst. Co.
American Inst. Co.
Bacharach Industrial Inst.
Baldwin-Lima-Hamilton
Cambridge Inst. Co.
Commerical Research
Crosby Steam Gage Co.
Eclipse-Pioneer Div.
Edison Electrical Controls
Electric Tachometer
Electro Products Labs.
Flader Inc., Fredric
Federal Telegraph
General Electric
Hathaway Inst. Co.
Hickok Elec. Inst. Co.
Hobbs Corp.
Kollsmann Inst. Div.
Lewis Engineering
Marsh Corp.
Photocon Research
Rutishauser Corp.
Skaneateles Mfg. Co.
Trimount Inst. Co.

INDICATORS, Engine Compression
Aero Electronics
Aeromarine Inst. Co.
Bacharach Industrial Inst.
Baldwin-Lima-Hamilton
Cambridge Inst. Co.
Commercial Research
Electro Products Labs.
Instrument Lab. Inc.
Marsh Corp.
Photocon Research
RCA
Trimount Inst. Co.
Witt Gage Co.

INDICATORS, Ignition Lag
American Instrument

INDICATORS, Multiple Recording
Alden Products
Alfax Paper & Engg.
Commercial Research
Eclipse-Pioneer Div.
Hays Corp.
Leeds & Northrup
Taylor Instrument Co.
Thwing-Albert Inst. Co.

INDICATORS, Rate of Climb
Aeromarine Inst. Co.
Automatic Temp. Control
Eclipse-Pioneer Div.
Kollsman Inst. Div.
Mason-Neilan Co.
Rieker Inst. Co.
Summers Gyroscope

INDICATORS, Sight Flow
Bausch & Lomb
King Engr. Corp.
Sarco Co.
Shand and Jurs
Trinity Equipment

INDICATORS, Sound
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Amperite Corp.
Audio Tone Oscillator
Clough-Brengle Co.
Daven Co.
Feiler Engineering
General Elec. Co.
General Radio
Kay Electric
Marion Electrical Inst.
Minnesota Electronics
Polarad Electronics
RCA
Reed Research

INDICATORS, Time Interval see Timers, Automatic, Interval

INDUCTANCE METERS
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Boonton Radio Corp.
Electronic Dev. Lab.
Feiler Engineering
Freed Transformer
General Elec. Co.
General Radio
Industrial Instruments
Leeds & Northrup Co.
Premier Crystal Labs.
Rubicon Co.
Shallcross Mfg. Co.
Sickles Co.

INSPECTION, Glass & Quartz, (see Immersion Liquids)

INSPECTION DEVICES, Optical Projection
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Bausch & Lomb
Compar Instrument
Eder Instrument
Engis Equipment
Hillyer Inst.
La Pine & Co., A. S.
Sheffield Corp.
Stocker & Yale
Unertl Optical Co.
Wilder Inc.

INSPECTION DEVICES, AUTOMATIC, Color
Electric Eye Equip.
Gardner Laboratory
Huggins Labs.
Instrument Dev. Labs.

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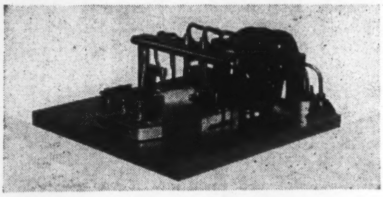

Unit with cover removed, showing precision part being processed.

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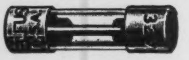

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Martin-Hubbard Corp.
Moore Products
Photoswitch, Inc.
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Sheffield Corp.
Size Control Co.
Swedish Gage Co.

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Electric Eye Equip.
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Gaertner Scientific Corp.
Graham-Mintel Inst.
Martin-Hubbard Corp.
Moore Products
Photoswitch, Inc.
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Autotron Co.
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Gaertner Scientific Corp.
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Martin-Hubbard Corp.
Metron Instrument
Moore Products
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INSPECTION DEVICES, AUTOMATIC, Electrical
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Berkshire Laboratories
Clarke Inst. Corp.
Clippard Inst. Lab.
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Dice Co., J. W.
Do-All Co.
Electric Eye Equip.
Electronic Dev. Lab.
Electro Products Lab.
Feiler Engineering
General Electric
Hillyer Instrument
Industrial Inst. Inc.
Industrial Timer Corp.
Martin-Hubbard Corp.
Nankervis Co., G. L.
Photoswitch, Inc.
Poole Instruments
Size Control Co.
Sperry Products
Thordarson Elec. Mfg.
Wheelco Insts. Co.
Wilmotte, Inc.

INSPECTION DEVICES, AUTOMATIC, Hardness
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Brabender Corp.
Detroit Testing Mach.
General Electric
DoAll Co.
Gogan Machine
Olsen Testing Machine
Rowe Engineering
Swedish Gage Co.

INSPECTION DEVICES, AUTOMATIC, Insulated Wire
Berkshire Laboratories
Comtor Co.
Federal Products Corp.

INSPECTION DEVICES, AUTOMATIC, Smoothness
Brush Development
Compar Inst. Co.
Comtor Co.
DoAll Co.
Electric Eye Equip.
Electronic Prod. Co.
Federal Products Corp.
General Electric
Photoswitch, Inc.
Physicists Research Co.
Sheffield Corp.
Swedish Gage Co.
Thwing-Albert Inst. Co.

INSPECTION DEVICES, AUTOMATIC, Thickness
Aero Electronics
Autotron Co.

(Continued)

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DoAll Co.
Electric Eye Equip.
Electronic Prod. Co.
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Gaertner Scientific Corp.
General Electric Co.
Hathaway Instrument
Industrial Nucleonics
Instrument Dev. Labs.
Magnaflux Corp.
Magnetic Gauge Co.
Moore Products
Nuclear Inst. & Chem.
Photocon Research
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Sheffield Corp.
Thwing-Albert Inst. Co.

INSPECTION EQUIPMENT, Arc Welding
General Elec. X-Ray Dept.
Magnaflux Corp.
Rubicon Co.
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INSPECTION EQUIPMENT, Bore Hole (See Telescopes, Bore, Inspection)

INSPECTION EQUIPMENT, Non-Destructive
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Branson Instruments, Inc.
Dice Co., J. W.
Engineers' Specialties Div.
Federal Products
General Elec. X-Ray Dept.
Gen. Precision Lab.
Genisco Inc.
Industrial Electronics
Kay Electric Co.
La Pine & Co., A. S.
Magnaflux Corp.
Menlo Research Lab.
Physicists Research Co.
Sheffield Corp.
Size Control Co.
Sperry Products
Stocker & Yale
Swedish Gage Co.
Tracerlab
Vacuum Electronic Corp.
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INSPECTORS, MAGNETIC
Aero Electronics
Annis Co.
Commercial Research
Dice Co., J. W.
Fraser Dev. Lab.
General Elec. Co.
Magnaflux Corp.
Magnetic Analysis Corp.
Rowe Engineering
Rubicon Co.
Western Ind. Eng.

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Magnaflux Corp.
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INSTRUMENT HOUSINGS (See Housings, Weatherproof, Instrument)

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Dow Corning
Eastern Specialty
Eclipse-Pioneer Div.
Elgin National Watch
Ferner Co.
Fulcrum Oil Co.
General Elec. Co.
Huisking & Co.
Landis & Gyr. Inc.
Marshall Co.
Mico Inst. Co.
Nye, Inc., William F.
Precision Scientific

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Gaunt Industries
Ideal Lab. Tool & Sup.
Johnson Scien. Inst.
Stafford Co.

INSTRUMENT TRANSFORMERS (See Transformers, Instrument)

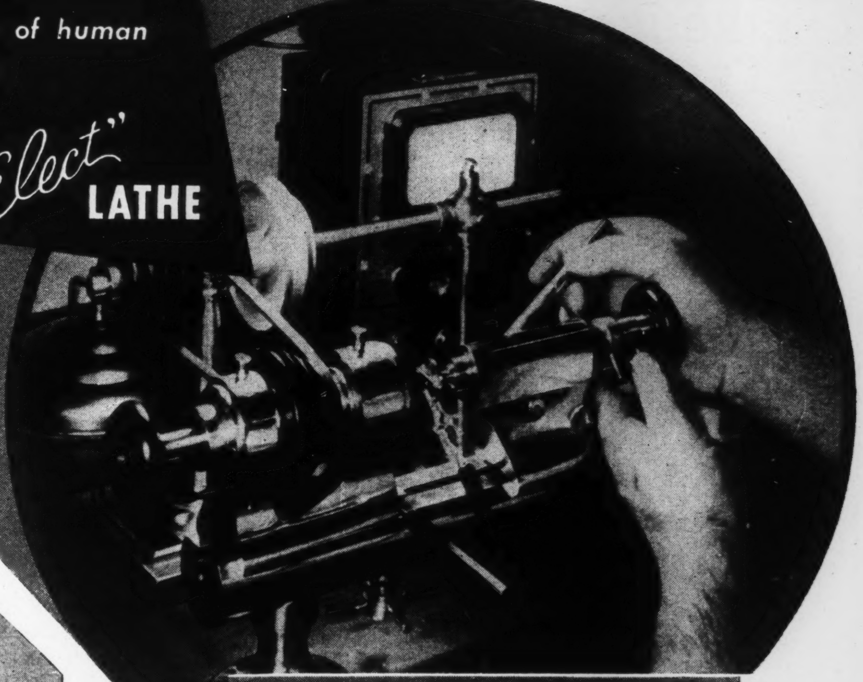
INSTRUMENT TUBING & FITTINGS
Crawford Fitting Co.
Imperial Brass Mfg.

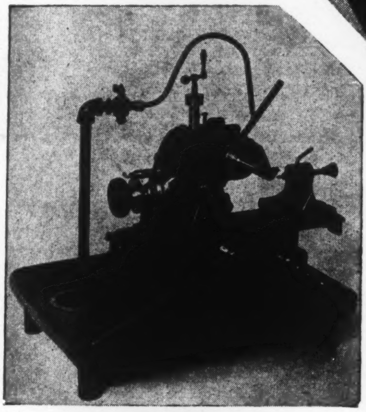
(Continued)

Drilling a $\frac{60}{100,000}$-inch diameter hole *(half that of human hair)* on a standard

DERBYSHIRE *"Elect"* LATHE

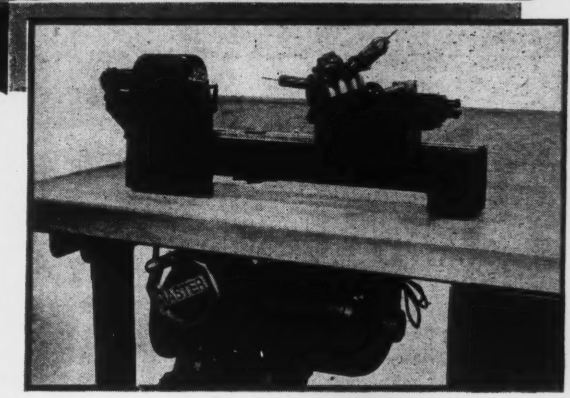
As performed at the U. S. Naval Ordnance Laboratory White Oak, Maryland





DERBYSHIRE MICROMILL

Model No. 750 with Ball Bearing Headstock, Cam-operated Vertical Slide, rack and pinion Table Slide, screw-feed Cross Slide, ⅜" diameter Cutter Arbor, Oil Pan, Coolant Pump.

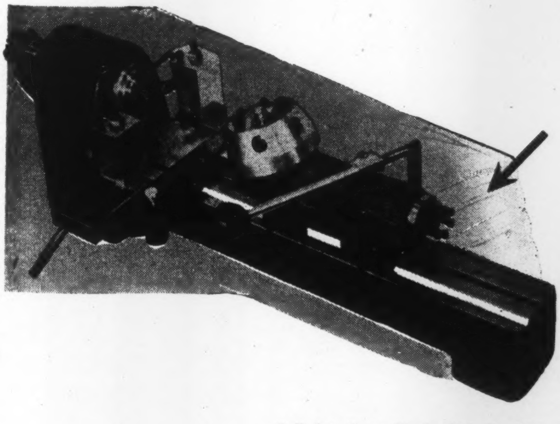


↑ **MODEL NO. 750 PRECISION LATHE**

Overall Length	24"
Distance between centers	
Length of bed	22"
Swing over bed	.905"
Motor	¼ HP Variable Speed
Spindle Speed (Max.)	18,000 RPM

Semi-automatic Turret with ⅝" holes

Maximum Collet Capacity—.315" (5/16")



Full details on Derbyshire Precision Lathes are available on request.

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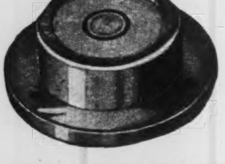

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- Jacobs Instruments
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- Librascope
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- Summers Gyroscope
- Taylor Instrument Cos.
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- Bausch & Lomb
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- Jarrel-Ash Co.
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- Optron Lab.
- Palos Optical Co.
- Perkin Elmer Corp.
- Zeiss, Inc., Carl

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- Doelcam Corp.
- Eclipse-Pioneer
- Eicor, Inc.
- Gothard Mfg.
- Holtzer-Cabot

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- Detectron Co.
- Kelley-Koett Inst. Div.
- Nuclear Inst. & Chemical
- Nucleonic Corp.
- Radioactive Products
- R-C Scientific Inst.
- Special Insts. Lab.
- Technical Associates
- Tracerlab
- Western Radiation Lab.

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- Calculagraph Co.
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- Dorothea Mechanisms, Gale
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- Foxboro Co.
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- Potter Instrument
- Stromberg Electric Co.

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- Beck Bros.
- Bunnell & Co.
- Cinema Engr.
- Clare & Co.
- Cook Electric
- Federal Telephone
- Kellogg Switchboard
- Leeds & Northrup Co.
- Mossman, Inc.
- Rubicon Co.
- Shallcross Mfg. Co.
- Winslow Co.

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- Leeds & Northrup Co.
- Sangamo Electric
- Westinghouse Elec.

KVA RECORDERS

- Esterline-Angus Co.
- General Elec. Co.
- Landis & Gyr, Inc.
- Leeds & Northrup Co.
- Sangamo Electric
- Westinghouse Elec.

KYMOGRAPHS

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- Central Scientific
- General Biological
- Gorrell & Gorrell
- Phipps & Bird
- Sargent & Co.
- Stoelting Co., C. N.
- Thomas Co., Arthur H.
- Westinghouse Elec.

LABORATORY APPARATUS (See Apparatus, Laboratory)

LABORATORY FURNITURE (See Furniture, Laboratory)

LABORATORY GLASSWARE (See Apparatus, Laboratory, Glass)

LABORATORY MOTORS (See Motors, Laboratory)

LABORATORY OVENS (See Ovens, Laboratory)

LABORATORY PORCELAIN (See Porcelain, Laboratory)

LABORATORY SUPPLIES (See Apparatus, Laboratory)

LACTOMETERS

- Central Scientific Co.
- Freas Glass Works
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- Ruehfel Co.
- Schultheis Corp.
- Tagliabue Div.
- Taylor Inst. Cos.
- Trerice Co.
- Welch Scientific

LAMPS, Pilot (See Pilot Lights)

LATHES, INSTRUMENT & ATTACHMENTS

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- Bayside Watch Tool
- Elgin National Watch
- Gallien, R. P.
- Koehler Inst. Co.
- Levin & Son, Louis
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- Georator Corp.
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- MacDonald Co., W. S.
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- Nucleonic Corp.
- Penberthy Instrument Co.
- R-C Scientific Inst.
- Tracerlab
- Western Radiation Lab.

LEAK INDICATORS, Gas & Water (See Gas Leak Indicators)

LENS THICKNESS GAGES

- Bausch & Lomb Optical
- Chicago Dial Ind. Co.
- Federal Products Corp.
- Instrument Dev. Labs.

LENSES, Astronomical (See Optical Parts)

LENSES, Burette (See Optical Parts)

LENSES, Low Reflecting Surfaces (See Optical Parts)

LENSES, Microscope, etc. (See Optical Parts)

LENSES, Polarized (See Optical Parts)

LENSES, Thermometer (See Optical Parts)

LEVELS, Abney

- Leupold & Stevens

LEVELS, Dumpy (See Surveying Instruments)

LEVELS, Engineer's (See Surveying Instruments)

LEVELS, Hand

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- Brunning Co., Inc.
- Brunson Instrument
- Dietzgen Co.
- Ferner Co.
- Gurley, W. & L. E.
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- Leupold & Stevens
- Millers Falls
- Pittsburgh Inst. & Mach.
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- Republic Lens Co.
- Standard Thermometer
- Starrett Co.
- Stratex Instrument Co.
- Suverkop Instruments
- United States Blue Print
- Warren-Knight Co.
- Weber Co., F.
- White Co. Inc., David

LEVELS, Precision

- Alpha Instrument Co.
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- Engis Equipment
- Ferner Co.
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- Glogau & Co.
- Gray Instrument
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- White Co., Inc., David
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- Republic Lens Co.
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- White Co. Inc., David

LEVELS, Spirit

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- Keuffel & Esser Co.
- Ruehfel Co.
- Warren-Knight Co.
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LEVELS, Surveying (See Surveying Instruments)

LEVELS, Wye (See Surveying Instruments)

LIGHT METERS (See Photometers, Illumination)

LIGHT SOURCES see also Gas & Vapor Discharge Tubes

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- Continental Electric
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- Erb & Gray
- E & S Optical
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- Larrimore Sales Co.
- Macbeth Corp.
- Stocker & Yale
- Sylvania Elec. Prod.

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- Berkshire Laboratories
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- Eby, Inc.
- Fisher-Pierce Co.
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- Gaertner Scientific Corp.
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- G-M Labs.
- Larrimore Sales Co.
- Leitz, Inc., E.
- Macbeth Corp.
- Rockwell Engr. Co.
- Stocker & Yale
- Sylvania Elec. Prod.

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- Fuess, Inc.
- Gaertner Scientific Corp.
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- Mico Instrument Co.
- Optron Laboratory
- Pfatz & Bauer, Inc.
- Phoenix Prec. Inst.
- Polarizing Instrument
- Precise Measurements Co.
- Rudolph & Sons
- Scherr Co., Inc.
- Van Keuren Co.

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- Gaertner Scientific Co.
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- Precise Measurements
- Sampson Chem. & Pigment
- Stocker & Yale
- Sylvania Elec. Prod.
- Ultra Violet Products
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- Gaertner Scientific Corp.
- General Elec. Co.
- Macbeth Corp.
- Sampson Chem. & Pigment
- Stocker & Yale
- Sylvania Elec. Prod.
- Westinghouse Elec. & Mfg.

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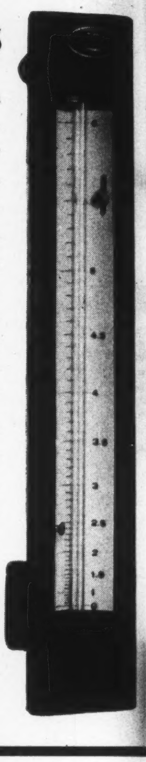

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LIQUID METERS, POSITIVE TYPES (See Meters, Liquid . . .)

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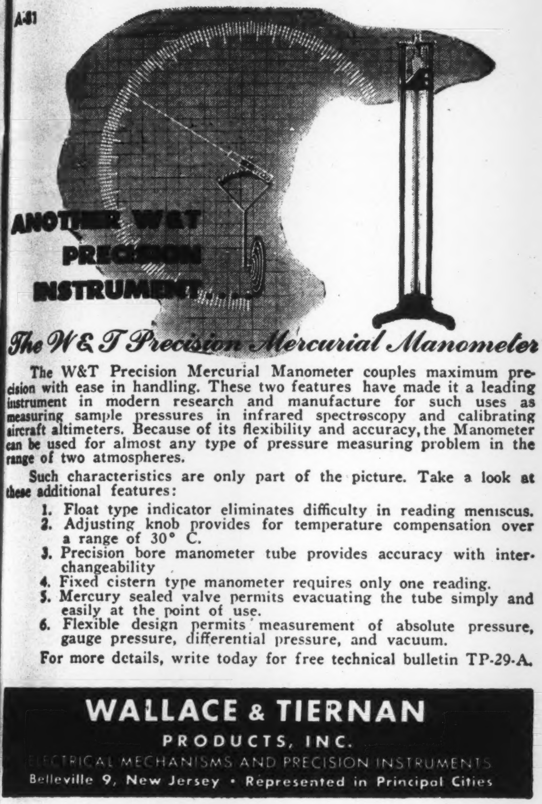

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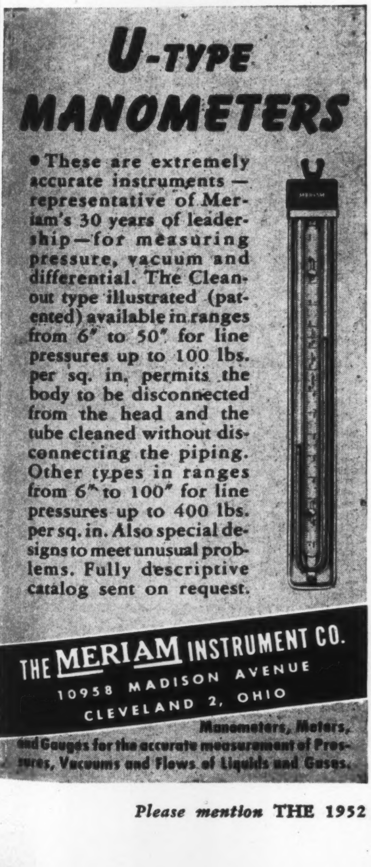

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Testrite Instrument Co.
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Refinery Supply Co.
Ruska Inst. Corp.
Shand & Jurs Co.

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Daniel Orifice Fitting
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Manning, Maxwell & Moore
Meriam Instrument
Minneapolis-Honeywell
Parks Co., Harry S.
Porter, George K.
Precision Scientific
Precision Thermometer
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Simplex Valve & Meter
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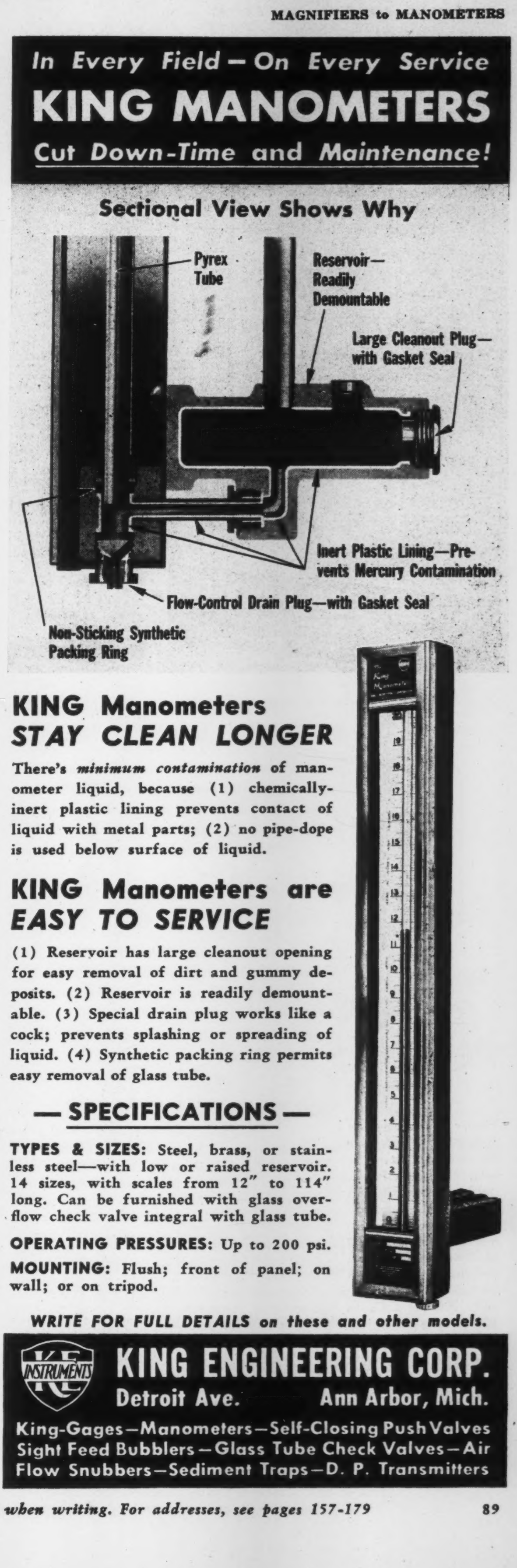

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King Manometer

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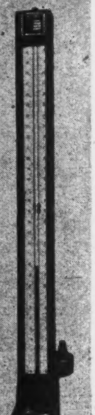

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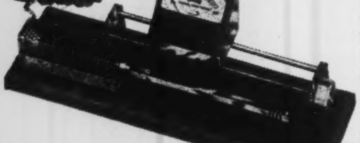

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Sensitive Research Inst.
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Sticht Co.
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General Elec. Co.
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Fischer & Porter
Mason-Neilan Regulator
N. J. Meter
Schutte & Koerting
Simplex Valve & Meter
Taylor Inst. Cos.

METERS, Condensation
Bailey Meter Co.
Buffalo Meter Co.
Fischer & Porter
Henszey Co.
Sparling, R. W.
Taylor Inst. Cos.

METERS, Conductivity (See Conductivity Meters)

METERS, Consumer's, Gas
American Meter Co.
Lambert Meter Co., Inc.
Superior Meter Co.

METERS, Counting Rate
Automatic Temp. Control
Berkeley Scientific
Cole Instrument
Douglas Radio Labs.
General Radio
Georator Corp.
Kelley-Koett Inst. Div.
MacDonald Co., W. S.
Nuclear Inst. & Chemical
Nuclear Research & Dev.
Nucleonic Corp.
Radioactive Products
R-C Scientific Inst.
Revere Corp.
Tracerlab
Western Radiation Lab.

METERS, Current, Air & Gas
American Meter Co.
Assembly Products
Commercial Research
Fischer & Porter
Kahl Scientific Inst.
Mason-Neilan Regulator
Schutte & Koerting

METERS, Current, Liquid
American Meter Co.
Badger Meter Mfg. Co.
Bowser & Co.
Builders-Providence
Commercial Research
Eclipse Aviation
Fischer & Porter
Keuffel & Esser Co.
Leupold & Stevens
Mason-Neilan Regulator
National Meter Co.
Neptune Meter Co.
Northwest Instrument
Schutte & Koerting
Scientific Inst. Co. (Calif.
Sparling, R. W.
Uehling Instrument Co.
Worthington Pump

METERS, Decibel (See Sound Level Meters)

METERS, Demand, Electric
Associated Research
Automatic Elec. Chicago
Burlington Inst. Co.
Duncan Elec. Mfg.
Electric Indicator Co.
Esterline-Angus Co.
General Elec. Co.
HD Elec. Co.
Landis & Gyr Inc.
Sangamo Electric Co.
Triplett Elec. Inst.
Westinghouse Elec.

METERS, Demand, Gas
American Meter Co.
Bailey Meter Co.
Bendix Marine Products
Lambert Meter Co.
Mason-Neilan Regulator
Superior Meter Co.

METERS, Demand Limiting, Automatic
American Meter Co.
Annis Co.
Esterline-Angus Co.
General Elec. Co.
Landis & Gyr, Inc.
Mason-Neilan Regulator
Westinghouse Elec.&Mfg.

METERS, Distortion
General Radio Co.
Hewlett-Packard
Kay Electric
RCA Div.
Scott, Inc., Hermon

METERS, Earth Current
Associated Research
Biddle Co., James G.
Borden Engineering
Cole Instrument
Geophysical Inst. Co.
Heiland Research
Miller, M. C.
Rawson Electrical Inst.
Shallcross Mfg. Co.
Westinghouse Elec.

METERS, Flow (See Flowmeters)

METERS, Fluorescence
Beckman Instruments
Coleman Electric
Farrand Optical
Menlo Research Lab.
Pfaltz & Bauer
Photovolt Corp.
R-C Scientific Inst.

METERS, Footage (See Counters, Footage)

METERS, Foot-candle (See Foot-candle Meters)

METERS, Frequency (See Frequency Meters)

METERS, Gas (See Gas Meters)

METERS, Gas, Dry Test
American Meter Co.
Hagan Corp.
Lambert Meter Co.
Republic Flow Meters
Rockwell Mfg.
Superior Meter Co.
Tagliabue Div.

METERS, Gas, Integrating
American Meter Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Div.
Builders-Providence
Fischer & Porter
Foxboro Co.
Hagan Corp.
Lambert Meter Co.
Mason-Neilan Regulator
Penn Ind. Inst. Corp.
Republic Flow Meters
Schutte & Koerting
Superior Meter Co.
Taylor Inst. Cos.

METERS, Gas, Wet Test
American Meter Co.
Lambert Meter Co.
Precision Scientific
Superior Meter Co.
Tagliabue Div.
Taylor Inst. Cos.

METERS, Gas, Station
American Meter Co.
Bowser & Co.
Smith Corp., A. O.

METERS, Gasoline (See Meters, Liquid)

METERS, High Pressure & High Pressure Distribution
Barton Instrument
Bristol Co.
Brodie Co., Ralph
Buffalo Meter
Builders-Providence
Foxboro Co.
Hagan Corp.
Hobbs Corp.
Penn Ind. Inst. Corp.
Republic Flow Meters
Revere Corp.
Rockwell Mfg.
Simplex Valve & Meter
Schutte & Koerting
Smith Corp., A. O.
Sprague Meter Co.

METERS, Hydrogen Ion (See Hydrogen Ion Determination Instruments)

METERS, Impedance
Beckman Insts.
Kay Electric Co.
Lavoie Labs.
Sperry Gyroscope Co.
Technology Instrument

METERS, LIGHT (See Foot-candle Meters, Illumination Indicators and Recorders, Light Meters, etc.)

METERS, Liquid, Volumetric Types, Nutating Piston or Disk
Askania Regulator Co.
Badger Meter Co.
Bowser, Inc.
Brodie Co.
Buffalo Meter Co.
Hays Corp.
Neptune Meter Co.
Rockwell Mfg.
Worthington Pump

METERS, Liquid Volumetric Types, Oscillating Piston
Badger Meter Co.
Brodie Co., Inc.
Neptune Meter Co.
Rockwell Mfg. Co.

METERS, Liquid, Volumetric Types, Propeller
Badger Meter Mfg. Co.
Builders-Providence
Henszey Co.
Rockwell Mfg.
Sparling, R. W.

METERS, Liquid, Volumetric Types, Reciprocating Piston
Askania Regulator Co.
Bowser Inc.
Brodie Co.
Rockwell Mfg.
Ruska Inst. Corp.

METERS, Liquid, Volumetric, Rotary Piston
Askania Regulator Co.
Badger Meter Co.
Bowser, Inc.
Brodie Co.
Revere Corp.
Rockwell Mfg.
Smith Meter Co.

METERS, Liquid, Volumetric, Special for Extremely Low Flow
Askania Regulator Co.
Bowser Inc.
Brooks Rotameter
Commercial Research
Fischer & Porter
Hays Corp.
Neptune Meter Co.
Schutte & Koerting
Yellow Springs Inst.

METERS, Liquid, Weighing
Bowser, Inc.
Commercial Research
Engineering Res. & Dev.
Richardson Scale Co.
Uehling Instrument

METERS, Mileage
Eclipse-Pioneer Div.
Engineering Res. & Dev.
Jaeger Watch Co.
Knopf Instrument
Ohmer Register
Sangamo Electric Co.
Speedometer Electric
U. S. Taximeter
Veeder-Root, Inc.

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METERS, Oil (See Meters, Liquid)

METERS, Orifice (See Flowmeters, Orifice)

METERS, Oxygen (See 1—Gas Analyzer; 2—Gas Meters)

METERS, Phase Angle (See Phase-Angle Meters)

METERS, Pitot Tube (See Flowmeters, Pitot Tube)

METERS, Positive Displacement (See Gas Meters, Positive and Liquid Meters, Volumetric)

METERS, Prepayment
American Meter Co.
General Electric Co.
Landis & Gyr, Inc.
Sangamo Electric Co.

METERS, Proportional
American Meter Co.
Bailey Meter Co.
Bristol Co.
Fischer & Porter
Foxboro Co.
Mason-Neilan Regulator
Minneapolis-Honeywell
Mittelman Electronics
Proportioneers, Inc.
Republic Flow Meters
Schutte & Koerting
Taylor Inst. Cos.

METERS, Reactive Component
Boonton Radio Corp.
Cole Instrument
Esterline-Angus Co.
General Elec. Co.
Landis & Gyr Inc.
RCA Manufacturing
Sangamo Electric
Triplett Elec. Inst.
Westinghouse Elec.
Weston Electrical Inst.

METERS, Rotary Displacement
Askania Regulator Co.
Bowser Inc.
Brodie Co.
Henszey Co.
Revere Corp.
Smith Corp., A. O.

METERS, Sewage
American Meter Co.
Bailey Meter Co.
Bristol Co.
Builders-Providence
Hagan Corp.
Hays Corp.
Leupold & Stevens
Mason-Neilan Regulator
Republic Flow Meters
Rockwell Mfg.
Simplex Valve & Meter
Taylor Inst. Cos.

METERS, Shunt
Builders-Providence
Burlington Inst. Co.
Cole Instrument
Columbia Elec. Mfg.
Dale Instruments
Daven Co.
Electronic Development
Fischer & Porter
Instrument Resistors
Radio City Products
Rawson Electrical Inst.
Reiner Electronics
Sangamo Electric
Shallcross Mfg.
Wheelco Inst. Co.
Westinghouse Elec.

METERS, Sight Flow
Bowser Inc.
Brooks Rotameter Co.
Commercial Research
Fischer & Porter Co.
Henszey Co.
Schutte & Koerting
Selas Co.

METERS, Station
American Meter Co.
Bristol Co.

METERS, Steam (See Flowmeters, Steam)

METERS, Time
Aero Instrument Co.
Alina Corp.
Amer. Chronoscope
Berkeley Scientific
Betts & Betts
Boeckeler Instrument
Bristol Co.
Cramer Co., Inc.
Cyclotron Specialties
Elec. Tachometer Corp.
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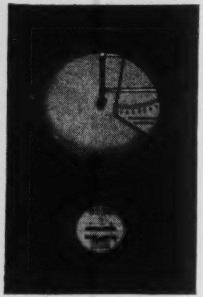

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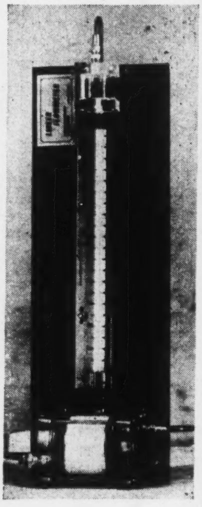

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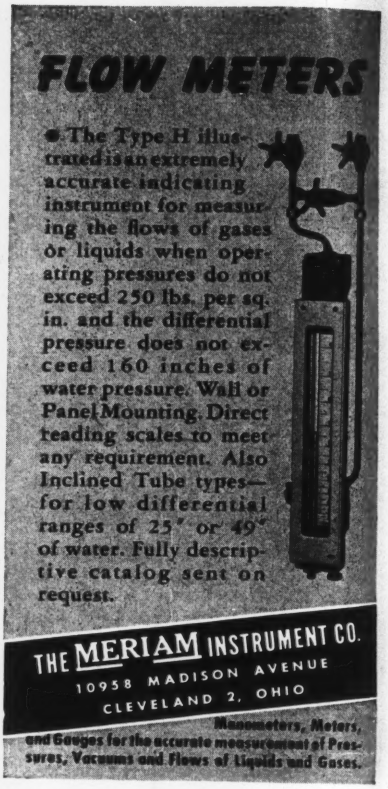

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Thompson Clock Co.
Walkirt Co.
Waltham Watch
Warren Telechron Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

METERS, Ultraviolet Radiation
Beckman Instruments
Farrand Optical
General Elec. Co.
Nuclear Inst. & Chem.
Pfaltz & Bauer
Photovolt Corp.
Westinghouse Elec.

METERS, Venturi (See Flowmeters, Venturi)

METERS, V-notch (See Flowmeters, Weir)

METERS, Volumetric, Positive Displacement (See Gas Meters, Positive; see Meters, Liquid, Volumetric)

METERS, Water (See Liquid Meters, Volumetric; also Flowmeters, Liquid)

METERS, Watt-Hour
Associated Research
Duncan Electric
General Elec. Co.
Landis & Gyr, Inc.
Roller-Smith
Sangamo Electric Co.
Sticht Co.
Veeder-Root
Westinghouse Elec.

METERS, Weir (See Flowmeters, Weir)

METERS, X-Ray Intensity
General Electric X-Ray
Georator Corp.
Marconi Instruments Ltd.
Nucleonic Corp.
Radiation Counter Labs.
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MICROAMMETERS (See Ammeters, Microammeters)

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MICRODENSITOMETERS (See Densitometers)

MICROFARADMETERS
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Bidwell Instrument
Gamma Inst. Co.
Industrial Instruments
Mico Instrument Co.
Process & Instruments
Zeiss, Inc., Carl

MICROMANOMETERS (See Manometers, Micro)

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Size Control Co.

MICROMETERS, Dial
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Amthor Test. Mach.
Cady & Co., E. J.
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Federal Products Corp.
Ferner Co.
Gen. Engg. & Model Wks.
Glogau & Co.
Marshall Co.
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Park Sales
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MICROMETERS, Electronic
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Electro Products Labs.
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Graham-Mintel Inst.
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Maveg Machine Sales
Millers Falls
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Pratt & Whitney
Rimat Machine
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Size Control Div.
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Starrett Co.
Swedish Gage

MICROMETERS, Filar Eyepiece
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Fecker, Inc.
Ferner Co.
Gaertner Scientific Corp.
Jarrell-Ash Co.

MICROMETER, Flying
Magnetic Gauge Co.

MICROMETER, Internal
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Lufkin Rule Co.
Maveg Machine Sales
Micro Products Co.
Millers Falls Co.
Poole Instruments
Rimat Machine
Scherr Co., Inc.
Slocomb Co., J. T.
Starrett Co.
Swedish Gage
Zeiss, Inc., Carl

MICROMETERS, Optical
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Fecker, Inc.
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Instrument Dev. Labs.
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Mann Co., W. I.
Mogey & Sons
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Scherr Co., Inc.
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Unertl Optical Co.
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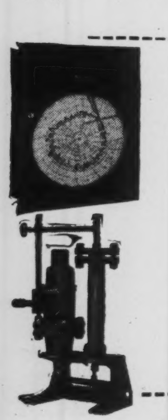

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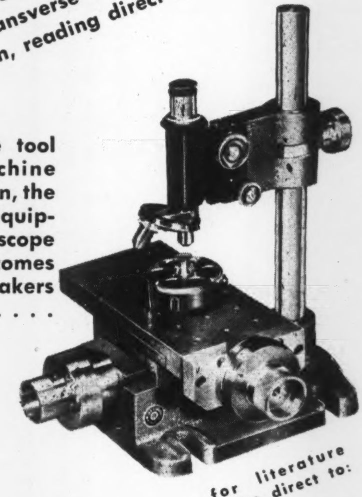

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MICROSCOPES, Ballistic, Comparison
Bausch & Lomb Optical
Ferner Co.
Jarrell-Ash Co.
Leitz, Inc.
Zeiss, Inc.

MICROSCOPES, Binocular
American Optical
Bausch & Lomb Optical
Boehmke Optical Co.
Federal Mfg. & Eng.
Ferner Co.
General Biological
International Micro
Jarrell-Ash Co.
Leitz, Inc.
Lovins Engr.
Polarizing Instrument
Scherr Co., Inc.
Zeiss, Inc., Carl

MICROSCOPES, Biological (See Microscopes, Binocular)

MICROSCOPES, Brinell
Bausch & Lomb Optical
Boeckeler Instrument
Detroit Testing Mach.
Ferner Co.
Fisher Scientific Co.
Gaertner Scientific Corp.
Gordon Co.
Leitz, Inc.
Olsen Testing Machine
Pittsburgh Inst. & Mach.
Riehle Division
Steel City Testing Mach.

MICROSCOPES, Dark Field
Aloe Co., A. S.
American Optical
Bausch & Lomb Optical
Ferner Co.
International Micro
Polarizing Instrument

MICROSCOPES, Electron
Farrand Optical
General Electric Co.
North American Philips
RCA Div.

MICROSCOPES, Finish Comparison
American Optical
Bausch & Lomb Optical
Compar Instruments
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Engineers Specialty Div.
Engis Equipment
Fecker, J. W.
Ferner Co.
Gaertner Scientific Corp.
Instrument Dev. Lab.
Leitz, Inc.
Optical Development Corp.
Pike & Co., E. W.
Scherr Co., Inc.
Stratex Instrument Co.
Zeiss, Inc., Carl

MICROSCOPES, Inspection (See Microscopes, Finish Comparison)

MICROSCOPES, Measuring
American Optical
Bausch & Lomb Optical
Central Scientific Co.
Clarkstan Corp.
Dome Precision
Engis Equipment
Fecker, J. W.
Ferner Co.
Gaertner Scientific Corp.
Griswold Mfg. Co.
Instrument Dev. Lab.
Jarrell-Ash Co.
Leitz, Inc.
Maveg Machine Sales
Mico Instrument Co.
Palos Optical Co.
Scherr Co., Inc.
Stebar Co.
Wilder, R. S.
Zeiss, Inc., Carl

MICROSCOPES, Metallographic
Abrams Instrument
American Optical
Bausch & Lomb
Ferner Co.
Gamma Inst. Co.
General Biological
Leitz, Inc.
Lovins Engr.
Mico Instrument Co.
Optical Service & Dev.
Pfaltz & Bauer, Inc.
Scherr Co., Inc.
Stocker & Yale
Zeiss, Inc., Carl

MICROSCOPES, Petrographical
American Optical
Bausch & Lomb Optical
Ferner Co.
Leitz, Inc.
Polarizing Instrument
Zeiss, Inc., Carl

MICROSCOPES, Thread Contour (See Microscopes, Finish Comparison)

MICROSCOPES, Toolmaker's
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American Meas. Insts.
Bausch & Lomb Optical
Boeckeler Instrument
Clarkstan Corp.
Dome Precision
Engis Equipment
Ferner Co.
Gaertner Scientific Corp.
Goerz Amer. Optical
Leitz, Inc.
Maveg Machine Sales
Mico Instrument Co.
Pfaltz & Bauer
Scherr Co., Inc.
Stratex Instrument Co.
Zeiss, Inc., Carl
Zenith Optical Co.

MICROSCOPES, Wire Gaging
Bausch & Lomb Optical
Clarkstan Corp.
Ferner Co.
Zeiss, Inc., Carl

MICROTOMES
American Optical
Baldwin Locomotive
Bausch & Lomb Optical
Cambridge Inst. Co.
Central Scientific Co.
Ferner Co.
International Equip. Co.
Jarrell-Ash Co.
Leitz, Inc.
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Thomas Co., Arthur H.

MICROVOLTMETERS (See Voltmeters, Micro)

MILEAGE METERS (See Meters, Mileage)

MILK TESTERS (See Testers, Milk)

MILLIAMMETERS (See Ammeters, Milliammeters

MILLIOHMMETERS (See Voltmeters, Millivoltmeters)

MILLIVOLTMETERS (See Voltmeters, Millivoltmeters)

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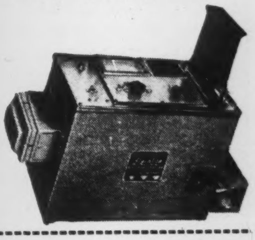

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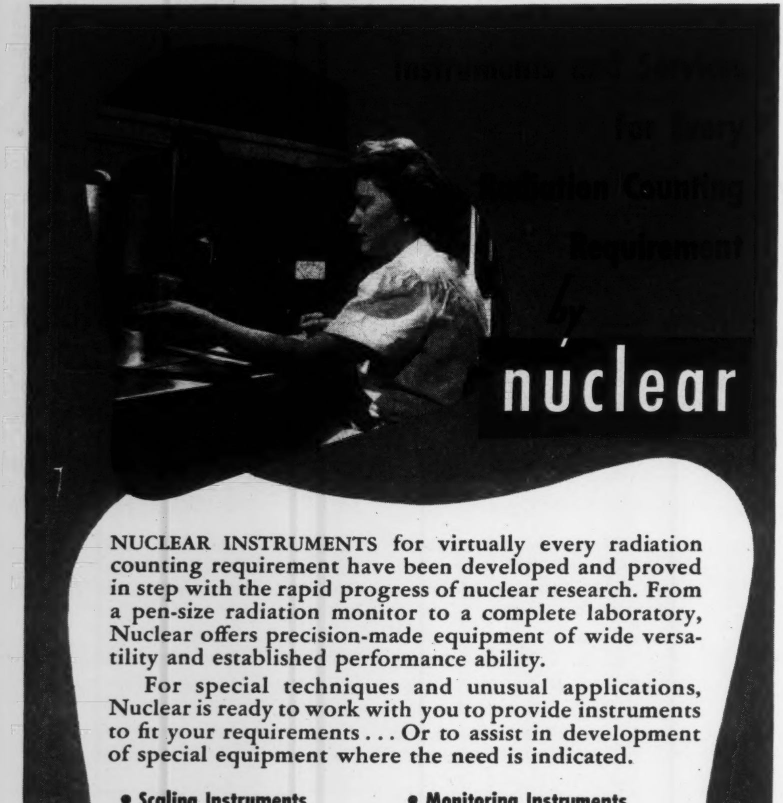

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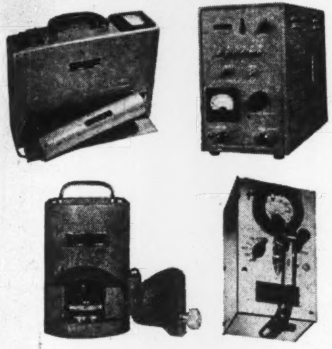

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Current	105 milliamperes	130 milliamperes	155 milliamperes
Power	0.90 watts	1.4 watts	1.9 watts
Impedance	85+j240 ohms	80+j180 ohms	77+j149 ohms
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Voltage max. (rotor output)	18.0 volts	15.5 volts	13.3 volts
Voltage at null	30 millivolts	20 millivolts	20 millivolts
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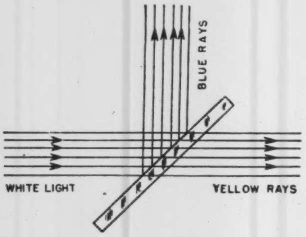

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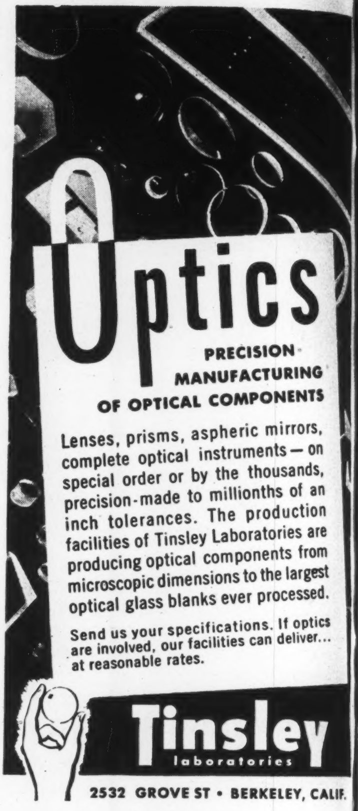
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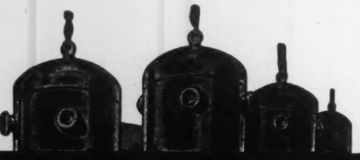

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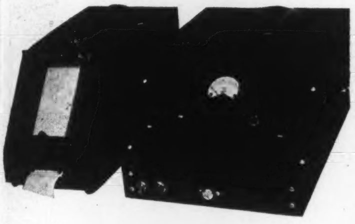

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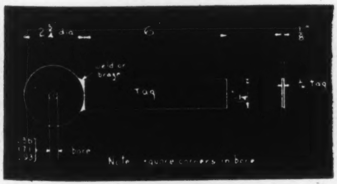

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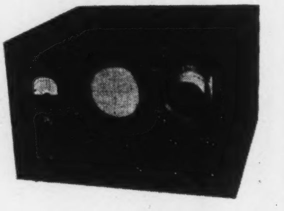

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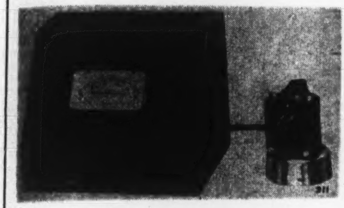
Electron-multiplier Photometer



This unit represents the latest advance in sensitive photometers. Portable detector unit has rotary shutter with five apertures and a dark position. Cabinet contains two complete line-operated stabilized power supplies, a bridge type amplifier and a micro-ammeter calibrated in percent transmission. Controls include (left to right) on-and-off switch, dark-current compensator, sensitivity selector and 100% adjuster.

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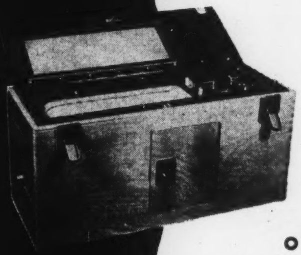

OSCILLOGRAPHS

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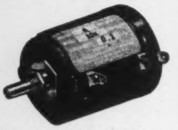

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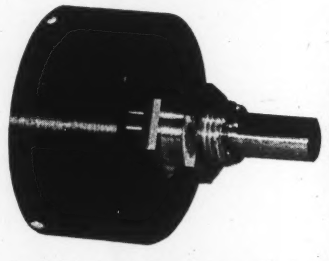

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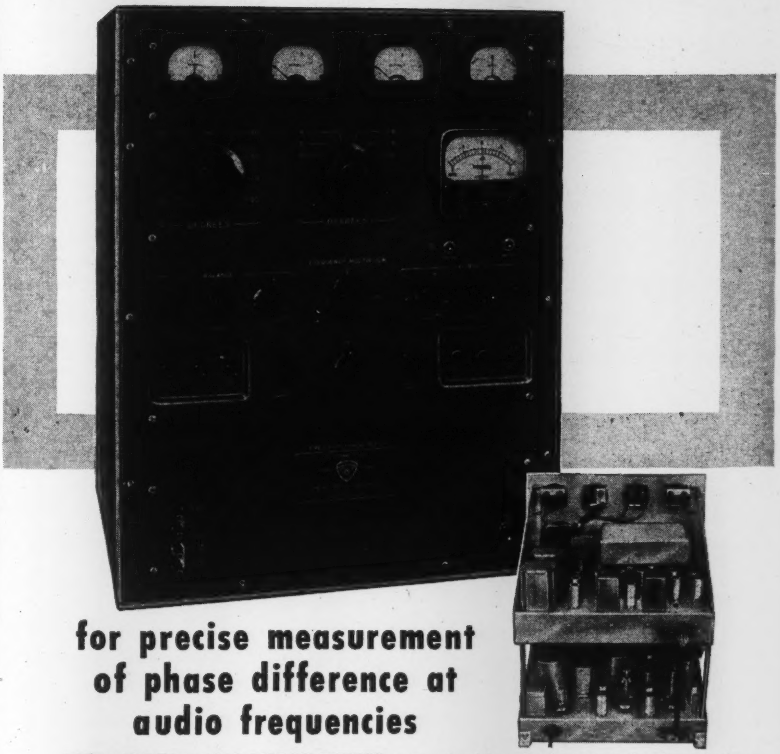

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Employing the phase-comparison method, the instrument exhibits a high degree of accuracy and incremental discrimination. The calibration may be checked with auxiliary equipment available in most laboratories. Even-order harmonic distortion is cancelled and odd-order distortion up to 1% will not affect accuracy of reading.

SPECIFICATIONS

Frequency range	30 to 20,000 cps
Phase range	0 to 360 degrees
Accuracy	0.1 degree
Incremental discrimination	0.01 degree
Signal level	0.5 to 10 volts rms
Input impedance	10 megohms shunted by 25 μ
Display	Decade null system
Output jack	Can be provided for operating external recorder
Power requirements	200 watts at 105-125 volts, 60 cycles
Size	19½" wide, 16¼" deep, 25" high
Weight	110 pounds
Cabinet	Internally shielded walnut cabinet.

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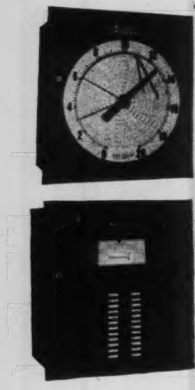

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Automatic Temp. Control
Bailey Meter Co.
Baldwin-Lima-Hamilton
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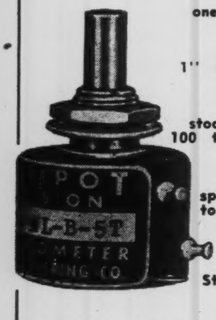
(Continued)

FORD
MULTIPOT
Helical Type
wire wound precision
POTENTIOMETERS



one to ten turns

1" and 1½" dia.

stock resistances
100 to 100,000 ohms

special resistances
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Three
Standard Types

Furnished with or without Linearity Guarantee to—.05%

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Prompt Shipment most types

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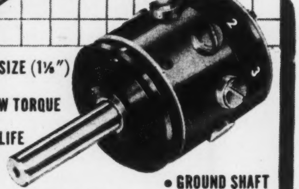
SYNCROMOUNT POTENTIOMETER



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- LOW TORQUE
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- GROUND SHAFT
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Giannini, standard with the leaders, develops this small ballbearing potentiometer with a variety of unique features to meet the latest computer requirements. Runout and concentricity within .001 in. Total resistance up to 100,000 ohms, torque less than 0.2 inch ounces.

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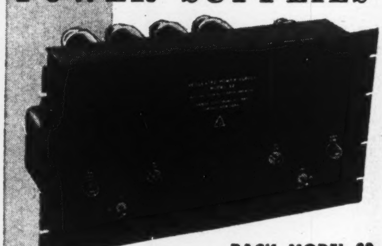
ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES



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STABLE • DEPENDABLE • MODERATELY PRICED

STANDARD RACK MOUNTING PANEL SIZE 10½" x 19" DEPTH 9" WEIGHT 38 LBS

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- **OUTPUT #2:** 6.3 Volts AC CT at 5A unregulated
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- **RIPPLE OUTPUT:** Less than 10 millivolts rms

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Linear Stabilized

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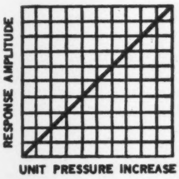
Completely Re-engineered, it now provides greater accuracy in measuring and recording pressure-time studies of dynamic, static and transient pressure phenomena. In addition to its wide range (from a few ounces to 10,000 PSI) and broad frequency response (static or zero to over 20,000 CPS) it offers these new exclusive features:



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Measures Dynamic or Static Displacement, Vibration or Movement of Any Metal Body Without Physical Contact
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Parr Instrument Co.
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Engineering Res. & Dev.
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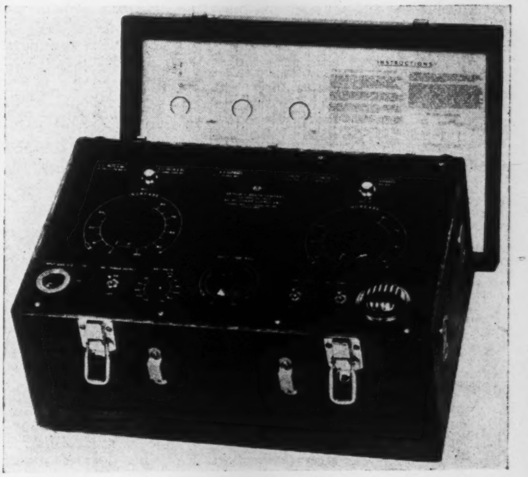

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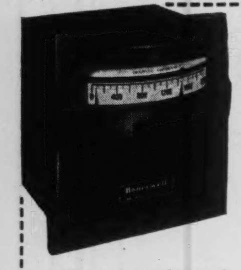

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Indicating Controllers

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Dickson Co.
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Hays Corp.
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Taglibue Div.
Taylor Inst. Cos.
Trerice Co.
Trimount Inst. Co.
U. S. Gauge
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Cook Electric
Electro Products Lab.
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Rubicon Co.
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Statham Labs.
Trimount Inst. Co.
U. S. Gauge Co.

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Bristol Co.
Defender Inst. & Reg.
Dickson Co.
Foxboro Co.
Hays Corp.
Magnetrol Inc.
Mason-Neilan Regulator
Minneapolis-Honeywell
Republic Flow Meters
Shallcross Controls
Taylor Inst. Cos.
Uehling Inst. Co.

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Perfex Corp.
Taylor Instrument Cos.

PRESSURE INDICATORS, Piezoelectric
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Gulton Mfg.
Martin-Hubbard Corp.
Massa Labs.
RCA Manufacturing

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Coleman Inst. & Mfg.
Hagan Corp.
Mansfield & Green
Republic Flow Meters
Ruska & Co.

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Dwyer Mfg. Co.
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Gas App. Specialties
Ideal Lab. Tool
Manning, Maxwell & Moore
Meriam Instrument
Parks Co., Harry S.
Precision Therm.
Uehling Instrument Co.

PRESSURE INDICATORS, Spring-loaded piston
Bacharach Indus. Inst.
Commercial Research
Mansfield & Green

PRESSURE INDICATORS, U-tube
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Amthor Test. Mach.
Automatic Temp. Control
Bacharach Indus. Inst.
Bailey Meter Co.
Connelly Iron Sponge
Defender Inst. & Reg.
Dwyer Mfg. Co.
Electronics Products Co.
Friez Instrument Div.
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Hays Corp.
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Manning, Maxwell & Moore
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Meriam Instrument
Moeller Instrument Co.
Parks Co., Harry S.
Precision Therm.
Refinery Supply Co.
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Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
Trimount Inst. Co.
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Vapor Recovery System

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Flader, Fred
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M B Mfg. Co.
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Pickering & Co.
Radio Corp. of Am.
Rahm Instruments Inc.
Servomechanisms Inc.
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Sperry Products
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Bristol Co.
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Defender Inst. & Reg.
Dickson Co.
Engineering Res. & Dev.
Esterline-Angus Co.
Flader Inc., Fredric
Foxboro Co.
Gorrell & Gorrell
Gotham Inst. Co.
Hays Corp.
Manning, Maxwell & Moore
Mason-Neilan Regulator
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Republic Flow Meters
Summers Gyroscope
Tagliabue Div.
Taller & Cooper
Taylor Inst. Cos.
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Baldwin Locomotive
Bristol Co.
Builders-Providence
Crosby Steam Gauge
Defender Inst. & Reg.
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Esterline-Angus Co.
Foxboro Co.
Giannini & Co.
Gordon Co., Claud S.
Gotham Inst. Co.
Hays Corp.
Improved Gauge Mfg. Co.
Kahl Scientific Inst.
Kenyon Instrument Co.
Leeds & Northrup Co.
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Penn Ind. Inst. Corp.
Powers Regulator
Republic Flow Meters
Summers Gyroscope
Tagliabue Div.
Taylor Inst. Cos.
Thrush & Co., H. A.
Trerice Co.
U. S. Gauge
Weksler Thermometer

PRESSURE RECORDERS, Capsular spring
Automatic Temp. Control
Cook Electric
Manning, Maxwell & Moore
Penn Ind. Inst. Co.
Republic Flow Meters
Tagliabue Div.

PRESSURE RECORDERS, Diaphram
Automatic Temp. Control
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Bristol Co.
Cook Electric
Defender Inst. & Reg.
Dickson Co.
Engineering Res. & Dev.
Foxboro Co
Giannini & Co.
Gotham Inst. Co.
Hays Corp.
Manning, Maxwell & Moore
Marsh Corp., Jas. P.
Mason-Neilan Regulator
Penn Ind. Inst. Corp.
Powers Regulator
Republic Flow Meters
Sanborn Co.
Sheffield Corp.
Tagliabue Div.
Taylor Inst. Co.
Wheelco Instruments

PRESSURE RECORDERS, Electrical-resistance
Aeroquip Corp.
Baldwin-Lima-Hamilton
Cole Instrument
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Flader Inc., Fredric
Giannini & Co.
Hathaway Instrument
Heiland Research
Minneapolis-Honeywell
Republic Flow Meters
Sheffield Corp.
Statham Labs.
Summers Gyroscope
Trimount Inst. Co.
Yellow Springs Inst. Co.

PRESSURE RECORDERS, Inverted-bell
American Meter Co.
Automatic Temp. Control
Bacharach Indus. Inst.
Bailey Meter Co.
Bristol Co.
Dickson Co.
Foxboro Co.

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Hays Corp.
Leeds & Northrup Co.
Mason-Neilan Regulator
Penn Ind. Inst. Corp.
Republic Flow Meters
Taylor Inst. Cos.
Uehling Instrument Co.

PRESSURE RECORDERS, Membrane
Bailey Meter Co.
Defender Inst. & Reg.
Hays Corp.
Mason-Neilan Regulator
Republic Flow Meters
Taylor Inst. Cos.

PRESSURE RECORDERS, Piezolectric
Brush Development Co.
Massa Labs.
RCA Manufacturing Co.

PRESSURE RECORDERS, Piston, weight-loaded
Bailey Meter Co.

PRESSURE RECORDERS, Single-tube liquid column
Trerice Co.
Uehling Instrument Co.

PRESSURE RECORDERS, Spring-loaded piston
Bacharach Indus. Inst.
Baldwin-Lima-Hamilton
Commercial Research
Hays Corp.

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Hays Corp.
Manning, Maxwell & Moore
Mason-Neilan Regulator
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Tagliabue Div.
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Marsh Corp.
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Curtiss Labs.
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Geophysical Inst. Co.
Glendale Optical
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Henson Co., Fred C.
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Jarrell-Ash Co.
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Plummer & Kershaw
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Schneider-Cogswell
Simpson Optical
Tinsley Labs.
Univis Lens Co.
Valpey Crystals

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PROBES, TEST, High Potential
Electronic Instrument
Electro-Tech Equipment
Feiler Engineering

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PROFILE-RECORDERS, Roughness Waviness, etc.
Automatic Temp. Control
Brush Development
Industrial Electronics
Physicists Research Co.
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PROGRAM CLOCKS (See Timers, Automatic Process)

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Bolsey Corp.
Bray Optical Co.
De Vry Corp.
Dome Precision
Eastman Kodak Co.
General Biological
G-M Laboratories
Leitz, Inc.
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RCA

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American Meas. Insts.
American Optical
Bausch & Lomb Optical
Bell & Howell Co.
Beseler Co., Charles
Bolsey Corp.
Burton Mfg. Co.
DeVry Corp.
Dome Precision
Eastman Kodak Co.
Fish-Schurman Corp.
General Biological
G-M Laboratories
Leitz, Inc.
Pflatz & Bauer
Stocker & Yale
Zeiss, Inc.

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Bausch & Lomb
Beseler, Co., Charles
Dorothea Mechanisms, Gale
Engineers' Specialties Div.
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Sheffield Corp.
Stocker & Yale
Unertl Optical
Wilder Inc.

PROJECTORS, Oscillogram
Consolidated Engr.
Radioactive Products
Telecomputing Corp.

PROJECTORS, Rectifying
Abrams Instrument

PRONY BRAKES, Hydraulic
Taylor Dynamometer

PROPORTIONING PUMPS See Pumps, Metering and Proportioning)

PROTRACTORS, Bevel (See Drawing Instruments)

PROTRACTORS, Course
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Bliss & Co.
Instrumaster Industries
Kenyon Instrument Co.
Keuffel & Esser Co.
Marine Compass Co.
Negus, T. S. & J. D.
Warren-Knight Co.

PROTRACTORS, Navigator's (See Protractors, Course)

PROTRACTORS, Transparent (See Drawing Instruments)

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Precision Scientific
Superior Meter Co.

PROVING RINGS
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Steel City Test. Mach.

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Electro-Physics Co.
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Gorrell & Gorrell

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H-B Inst. Co.
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Mason-Neilan Regulator
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Moeller Instrument Co.
Powers Regulator

PSYCHROMETERS, Electric (See Psychrometers, Aspiration)

PSYCHROMETERS, Recording (See Hygrometers, Recording)

PSYCHROMETERS, Sling
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American Moistening Co.
Central Scientific Co.
Chicago Apparatus Co.
Ever Ready Thermometer
Foxboro Co.
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Huddleston, J. S. F.
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Precision Scientific
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R-C Scientific Inst.
Rieker Inst. Co.
Rubicon Co.
Scientific Glass App.
Taylor & Co., W. A.

PULSATION DAMPER (See Pressure Snubber)

PULVERIZED MATERIALS MEASUREMENTS (See Granular Materials)

PUMPS, Compressed Air (See Air Compressors)

PUMPS, High Vacuum
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National Research Corp.
Phoenix Prec. Inst.
Precision Scientific
Refinery Supply Co.
Scientific Glass App.
Sterling Eng. Co.
Stoelting Co., C. H.
Stokes Machine Co.
Uehling Inst. Co.
Universal X-Ray Prods.
Welch Scientific

PUMPS, Hydraulic Control
Adel Precisiion Prods.
Barnes Co., W. F. & J.
Dusenbury Co.
Eastern Industries, Inc.
Eclipse-Pioneer Div.
Ingersoll-Rand
Lapp Insulator
Precision Scientific
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Hills-McCanna
Milton Roy Co.
Proportioneers Inc.
Ruska Inst. Corp.
Specialties Inc.

PUMPS, Metering and Proportioning
Baltimore Biological Lab.
Bowser, Inc.
Gelber Co., Samual S.
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on selection and application of thermocouples and pyrometer accessories

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113 BRISTOL RD., WATERBURY 20, CONN.

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BAILEY

Electronic Pyrometer

● This indicating, recording, and controlling BAILEY PYROTRON is a self balancing potentiometer which records one or two temperatures continuously on a 12-inch diameter chart and indicates on a 29-inch bold scale. It may be furnished with air-operated, electric, or electronic control.

A thermocouple or radiation unit is the temperature sensitive element.

Minimum maintenance is insured by elimination of galvanometers, millivolt meters, and continuously moving or vibrating mechanisms. A reversible electric motor under electronic control, balances the potentiometer network and drives the indicating, recording and controlling features.

Bailey Pyrotron Recorder-Controllers are made up of interchangeable assemblies, standardized so that only a few spare parts need be carried in stock to provide replacements for many instruments. Ask for Bulletin 232.

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Bailey Meter Company Ltd. Montreal Canada

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Eimer & Amend
Fisher Scientific Co.
G. M. Mfg. Co.
Humboldt Mfg. Co.
Leeds & Northrup
Pyrometer Inst. Co.
Rascher & Betzold,
Scientific Glass App.
Specialty Glass Co.

PYRHELIOMETERS
Cambridge Inst. Co.
Eppley Lab.
G. M. Mfg. Co.
Kahl Sci. Inst. Co.
Leeds & Northrup Co.
Pyrometer Inst. Co.

PYROMETER CALIBRATING SETS
Bristol Co.
Brown Inst. Div.
Cambridge Inst. Co.
DeJur-Amsco
Foxboro Co.
Illinois Testing Labs.
Leeds & Northrup Co.
Lewis Engineering
Pyrometer Inst. Co.
Rubicon Co.
Taco West Corp.
Tagliabue Div.
Thwing Albert Inst. Co.
Wheelco Inst. Co.
Winslow Co.

PYROMETERS, Electrical Resistance
Assembly Products
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
Cole Instrument
Dickson Co.
Electric Hotpack Co.
Engelhard, Chas.
Ferner Co.
Foxboro Co.
General Elec. Co.
Gordon Co., Claud S.
Gray Instrument
Ill. Tesing Labs.
J-B-T Inst., Inc.
Leeds & Northrup Co.
Lewis Engg. Co.
Loudon Insts.
Minneapolis-Honeywell
Phen-Trols, Inc.
Pyrometer Inst. Co.
Roller-Smith Co.
Rubicon Co.
Taco West Corp.
Tagliabue Div.
Thwing-Albert Inst. Co.
Wheelco Inst. Co.
Winslow Co.

PYROMETERS, Expansion
Burling Instrument Co.
Defender Inst. & Reg.
Ferner Co.
Lewis Engineering
Partlow Corp.
Pyrometer Inst. Co.
Tagliabue Div.
Thwing Albert Inst. Co.
Wheelco Insts. Co.

PYROMETERS, Indicating
Assembly Products
Bacharach Indus. Inst.
Bailey Meter Co.
Bristol Co.
Burling Inst. Co.
Burrell Tech. Supply
Cole Instrument
Defender Inst. & Reg.
DeJur-Amsco
Electric Hotpack Co.
Electronic Prod. Co.
Elematic Equip. Corp.
Engelhard, Chas.
Foxboro Co.
General Electric
Gordon Co., Claud S.
Gray Instrument
Ill. Testing Labs.
J-B-T Instruments
Leeds & Northrup Co.
Lewis Engg. Co.
Marshall Co., L. H.
Meters, Inc.
Minneapolis-Honeywell
Partlow Corp.
Pyramid Instrument Co.
Pyrometer Inst. Co.
Richards Co., Arkely S.
Roller-Smith Co.
Rubicon Co.
Taco West Corp.
Tagliabue Div.
Tamms Silica Co.
Taylor Inst. Cos.
Thermo Electric Co.
Thwing-Albert Instrument
Wheelco Inst. Co.
Winslow Co.

PYROMETER, Millivoltmetric
Assembly Products
Beede Elec. Inst.
Bristol Co.
Cambridge Inst. Co.
Cole Instrument
De Jur-Amsco Corp.
Elematic Equip Corp
Engelhard, Chas.
Foxboro Co.
General Elec. Co.
Gordon Co., Claud S.
Gray Instrument
Ill. Testing Labs.
J-B-T Instruments
Lewis Engr. Co.
Marion Electrical Inst.
Meters, Inc.
Minneapolis-Honeywell
Pyramid Instrument Co.
Pyrometer Inst. Co.

(Continued)

Richards Co., Arkley S.
Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst
Taco West Corp
Tamms Silica Co.
Taylor Inst. Cos.
Thermo Electric Co.
Thwing-Albert Instrument
Wheelco Inst. Co.
Winslow Co.

PYROMETERS, Optical
Bacharach Indus. Inst.
Burrell Technical Supply
Cambridge Inst. Co
Dietert Co
Electro-Tech Equip
Fisher Scientific Co
Gordon Co., Claud S.
Instrument Dev. Labs.
Leeds & Northrup Co.
Lewis Engineering
Minneapolis-Honeywell
Pyrometer Inst. Co.

PYROMETERS, Portable
Assembly Products
Bacharach Indus. Inst.
Bristol Co.
Burrell Technical Supply
Cambridge Inst. Co.
Cole Instrument
De Jur-Amsco
Electro-Tech Equip.
Elematic Equip. Corp.
Engelhard, Chas.
Ferner Co.
Foxboro Co.
Gordon Co., Claud S.
Gray Instrument
Ill. Testing Labs.
Instrument Lab., Inc.
J-B-T Instruments
Leeds & Northrup Co.
Lewis Engg. Co.
Meters, Inc.
Pyrometer Inst. Co.
Pyrometer Service Co.
Richards Co., Arkley S.
Roller-Smith
Rubicon Co.
Tagliabue Div.
Tamms Silica Co.
Thwing-Albert Instrument
Wheelco Instrument
Winslow Co.

PYROMETERS, Potentiometric
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
De Jur-Amsco
Dickson Co.
Foxboro Co.
General Electric
Gordon Co., Claud S.
Gray Engg. Co.
Leeds & Northrup
Lewis Engg. Co.
Loudon Insts.
Minneapolis-Honeywell
Pyrometer Inst. Co.
Rubicon Co.
Tagliabue Div.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Radiation, Controlling
Bacharach Indust. Inst.
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
Engelhard, Chas.
Foxboro Co.
General Elec. Co.
Gordon Co., Claud S.
Ill. Testing Labs.
Leeds & Northrup Co.
Minneapolis-Honeywell
Pyrometer Inst. Co.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Radiation, Indicating
Bacharach Indust. Inst.
Bristol Co.
Cambridge Inst. Co.
General Elec. Co.
Leeds & Northrup Co.
Lewis Engineering
Minneapolis-Honeywell
Pyrometer Inst. Co.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Radiation, Recording
Bacharach Indust. Inst.
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
General Elec. Co.
Gordon Co., Claud S.
Leeds & Northrup Co.
Minneapolis-Honeywell
Pyrometer Inst. Co.
Thwing-Albert Instrument

PYROMETERS, Thermoelectric, Immersion
Bailey Meter Co.
Bristol Co.
Burling Inst. Co.
Cambridge Inst. Co.
Cole Instrument
De Jur-Amsco
Elematic Equip. Corp.
Engelhard, Chas.
Ferner Co.
Foxboro Co.
General Elec. Co.
Gordon Co., Claud S.
Gray Instrument
Illinois Testing Labs.
J-B-T Instruments., Inc
Leeds & Northrup Co.
Lewis Engg. Co.
Marshall Co., L. H.
Meters, Inc.

(Continued)

PYRO —FOR PRECISION TEMPERATURE MEASUREMENTS

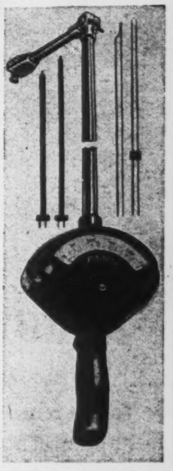
The Simplified PYRO OPTICAL is the only self-contained, direct reading, accurate and dependable unit for quick and accurate high temperature measurements. Unique construction permits determinations even on **Minute Spots, Fast Moving Objects** or of the **Smallest Streams. Special Foundry Type** and **Universal Triple Range** have additional Red Scale for direct readings of the true spout and pouring temperatures of molten iron, steel, monel, etc., when measured in the open.

Stock Ranges from 1400°F to 7500°F

Write for Catalog #80

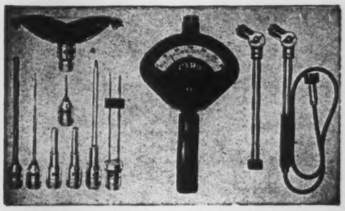
The NEW PYRO IMMERSION represents the acme of ruggedness, accuracy and dependability and is **Indispensable** in any **Modern** non-ferrous Foundry.

Constructed in a shock, moisture and dust-proofed shielded steel housing, it is immune to external magnetic influences and will withstand the roughest handling. "Bare metal" and "Protected" type thermocouples instantly interchangeable. Other features include the new, large 4¾" direct reading indicator, automatic cold end junction compensator and lock swivel.



Models available from 0-1000° F to 0-2500° F

Our Catalog #150 will interest you



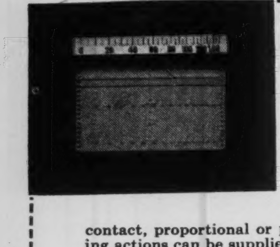
The NEW PYRO all-purpose Surface Pyrometer has been designed to meet all plant and laboratory surface and sub-surface temperature measurement requirements. Available in five temperature ranges from 0-300°F to 0-1200°F with a selection of eight types of interchangeable thermocouples and two extension arms. Also features automatic internal cold end junction compensator, shock, moisture and dust-proofed shielded steel housing.

Write for Catalog #165

THE PYROMETER INSTRUMENT CO.

Plant & Laboratory
Bergenfield 4, New Jersey

In Canada, Sales and Repair Laboratory:
Dominion Flow Meter Company Limited
Toronto and Montreal



Electronik

STRIP CHART POTENTIOMETERS

• Continuous balance electronic measuring circuit provides high accuracy, sensitivity and speed of response. Available for from 1 to 16 records with 4½, 12 or 24 seconds full scale pen travel on 12" chart. Chart speeds changeable between 1 and 120 inches per hour. Also available in single and double index types, with double, single and triple section charts. Control may be electric contact, proportional or pneumatic. Auxiliary mercury switches for various switching actions can be supplied on many models. Write for Catalog 15-15.

MINNEAPOLIS-HONEYWELL REGULATOR Co., *Industrial Division*, 4579 Wayne Ave., Phila. 44, Pa.

MINNEAPOLIS
Honeywell
Brown Instruments

Partlow Corp.
Pyrometer Inst. Co.
Pyrometer Service Co.
Revere Corp.
Richards Co., Arkley S.
Roller-Smith
Rubicon Co.
Taco West Corp.
Tagliabue Div.
Thwing-Albert Instrument
Wheelco Instruments
Winslow Co.

PYROMETERS, Thermoelectric, Indicating

Airflow Instrument
Alden Products
Alfax Paper & Engg.
Assembly Products
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
Cole Instrument.
DeJur-Amsco Corp.
Electro-Tech Equip.
Elmatic Equip. Corp.
Engelhard, Chas.
Feiler Engineering
Ferner Co.
Foxboro Co.
General Electric

(Continued)

Gordon Co., Claud S.
Gray Instrument
Hebler Co.
Huppert Co., K. H.
Ill. Testing Labs.
J-B-T Instruments, Inc.
Leeds & Northrup Co.
Lewis Engg. Co.
Meters, Inc.
Minneapolis-Honeywell
Partlow Corp.
Pyrometer Inst. Co.
Revere Corp.
Richards Co., Arkley S.
Roller-Smith
Rubicon Co.
Scientific Inst. Co.
Taco West, Corp.
Tagliabue Div.
Taylor Inst. Cos.
Thermo Electric Co.
Thwing-Albert Instrument
Wabash Metal Products
Wheelco Inst. Co.
Winslow Co.

PYROMETERS, Thermoelectric, Recording & Controlling

Assembly Products
Bacharach Indust. Inst.

(Continued)

Bailey Meter Co.
Beck Co.
Bristol Co.
Cambridge Inst. Co.
Cole Instrument
Engelhard, Chas.
Feiler Engineering
Foxboro Co.
General Elec. Co.
Gordon Co., Claud S.
Ill. Testing Labs.
Instrument Dev. Labs.
Leeds & Northrup Co.
Lewis Engg. Co.
Loudon Insts.
Mason-Neilan Regulator
Minneapolis-Honeywell
Partlow Corp.
Pyrometer Inst. Co.
Richards Co., Arkley S.
Taco West Corp.
Tagliabue Div.
Thwing-Albert Instrument
Wheelco Instruments

PYROMETERS, Thermoelectric, Suface Contact

Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
Cole Instrument
Elematic Equip. Corp.
Englehard, Chas.
Feiler Engineering
Ferner Co.
Foxboro Co.
General Elec. Co.
Gordon Co., Claud S.
Gray Instrument
Huppert Co., K. H.
Illinois Testing Labs.
J-B-T Instruments
Laboratory Specialties
Lewis Engg Co.
Pyrometer Inst. Co.
Pyrometer Service Co.
Revere Corp.
Taco West Corp.
Tagliabue Div.
Tamms Silica Co.
Thwing-Albert Instrument
Wheelco Instruments
Winslow Co.

PYROMETERIC CONES (See Cones, Pyrometric.)

Q METERS

Boonton Radio
Electro-Tech Equip.
Freed Transformer
General Electric Co.
Technology Instrument
United Transformer

QUARTZ, Fused Quartz Apparatus (see Apparatus, Laboratory, Fused Quartz

RADAR TRANSMITTERS AND MODULATORS

Amer. Electroneering
Laboratory for Electronics
Lavoie Labs.
Sperry Gyroscope Co.

RADIOACTIVITY DETECTING AND MEASURING EQUIPMENT

Abrams Instrument
Berkeley Scientific
Clarkstan Corp.
Cole Instrument
Detectron Co.
Douglas Radio Labs.
General Electric
Georator Corp.
Kelley-Koett Inst. Div.
Loudon Insts.
Lovins Engr.
MacDonald Co., W. S.
Menlo Research Lab.
Nuclear Dev. Lab.
Nuclear Inst. & Chem.
Nuclear Res. & Dev.
Nucleonic Corp.
Potter Instrument
Radiation Counter Labs.
Radioactive Products
R-C Scientific Inst.
Special Instruments Lab.
Stratex Instrument Co.

(Continued)

Technical Associates
Tracerlab
Western Radiation Lab.
Weston Elec. Inst.
Wood Counterlab

RADIOACTIVITY STANDARDS (See Standards, Radioactivity

RADIO ACTIVITY MEASURING INSTRUMENTS

Berkeley Scientific
Canadian Radium
Cyclotron Specialties
Geo hysical Inst. Div.
Herbach & Rademan
Instrument Div. Labs.
Martin-Hubbard Corp.
Radiation Counter Lab.
Sylvania Electric
Technical Associates
Tracerlab, Inc.
Victoreen Inst. Co.

RADIO BEACON SYNCHRONIZING CONTROLLERS

Beacon Gage Co.
Federal Telephone Co.
Islip Radio Mfg.
Radio Receptor Co.
Wallace & Tiernan

RADIO FREQUENCY Meters

Aero Instrument
Burlington Inst. Co.
Clough-Brengle Co.
Dale Instruments
De Jur-Amsco
Electronic Div. Lab.
Electro Products Lab.
Feiler Engineering
Ferris Inst. Corp.
General Elec. Co.
General Radio Co.
Hewlett-Packard
Hickok Elec. Inst. Co.
Kay Electric
Lampkin Laboratories
Measurement Corp.
Meters, Inc.
Miller Mfg. Co.
National Co.
Potter Instrument
Premier Crystal Labs.
Rawson Electrical Inst.
RCA Div.
Roller-Smith
Sensitive Research Inst.
Simpson Elec. Co.
Sherron Metallic
Sperry Gyroscope Co.
Triplett Electrical Inst.
Walkirt Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RADIO FREQUENCY OSCILLATORS (See Oscillators, Radio Frequency)

RADIO-MICROMETERS (Sss Micrometers, Radio)

RADIO REMOTE CONTROL SYSTEMS (See Controller Automatic, Radio Remote)

RADIO SET ANALYZERS (See Analyzers, Radio Set)

RADIOSONDES

Alden Products
Applied Science Corp.
Friez Instrument Div.
General Elec. Co.
Kollsman Inst. Div.
Reiner Electronics
Serdex, Inc.
Wallace & Tiernan

RADIO TUBE CHECKERS (See Analyzers, Radio Set)

RADIUM DETECTORS see Detectors, Radioactivity

RADIUM HANDLING EQUIPMENT

Radiation Counter Labs.
Western Radiation Lab.

RAIN GAGES

Ballauf Mfg. Co.
Central Scientific Co.
Friez Instrument Div.
Green, Henry J.
Gurley, W. & L. E.
Henson Co., Fred C.
Instruments Corp.
Keuffel & Esser Co.
Leupold & Stevens
Precision Thermometer
Stewart, M. C.
Taylor Inst. Cos.
Warren-Knight Co.
White Co., Inc.

RAINFALL RECORDERS

Friez Instrument Div.
Gorrell & Gorrell
Green, Henry J.
Instruments Corp.
Leupold & Stevens
Taylor Inst. Cos.

RANGE FINDING INSTRUMENTS

Bauch & Lomb
Farrand Optical
Fecker, J. W.
Fisher Research Corp.
Gartner Scientific Corp.
Hastings Inst. Co.
Keuffel & Esser Co.
Kollmorgen Optical Co.
Leitz, Inc.
Precision Thermometer
RCA Manufacturing
Stafford Co.
White Co., Inc.

RANGE POLES (See Surveying Instruments)

REACTANCE METERS

Clarke Inst. Corp.
Electro Products Lab.
Freed Transformer
General Elec. Co.
General Radio Co.
Premier Crystal Labs.
RCA Manufacturing
Rubicon Co.
Sensitive Research Inst.

REACTIVE VOLT-AMPERE METRES, See Volt-ampere Meters, Reactive

READING LENSES, Thermomenter & Burette (See Lenses, Reading)

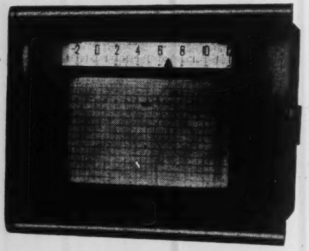
RECORDER, Magnetic Tape

Ampex Electric
Brush Development

(Continued)

PYROMETERS

For Measuring Temperatures To 4000° F.



Bristol Dynamaster Electronic Potentiometer Continuous-Balance Fast-Speed Instrument.

The Bristol line of pyrometers includes potentiometer, millivoltmeter, thermocouple and radiation types.
Automatic Pyrometer Controllers are available with any of the following types of control: Electric, Electronic, or Air-Operated.
A wide variety of temperature ranges and models are offered to fill most every industrial application.

Write for Bulletins P1200, P1242, P1244, and PB1237.

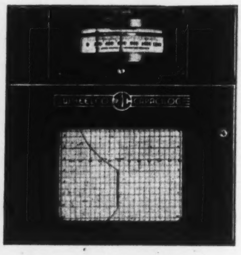
NEW FREE HANDBOOK ON THERMOCOUPLES

Write also for new combination handbook and catalog on thermocouples, tubes and accessories, P1238.

THE BRISTOL COMPANY
113 BRISTOL RD., WATERBURY 20, CONN.

instrumentality

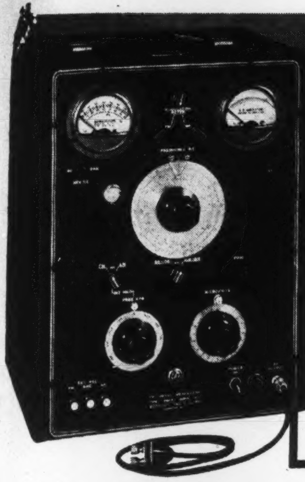
STRIP CHART RECORDER



for measurement, indication, control and permanent record!

Specify the Wheelco CAPACILOG — for fast, simple, precise and economical permanent recording — plus indication and control of temperature (-300°F to 3600°F), speed, static strain loads, AC or DC voltage, amperage and other electrically measurable factors. Get Wheelco instru*mentality* in action—ask for Condensed Catalog. Wheelco Instruments Company, 843 W. Harrison St., Chicago 7, Illinois.

wheelco *electronic controls*



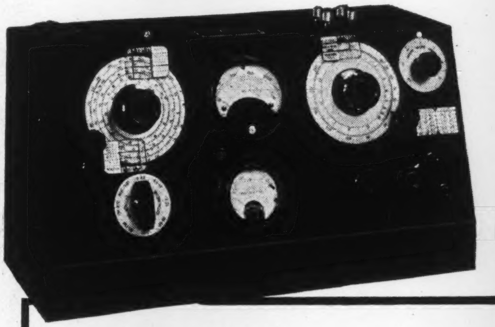
PRECISION MEASURING INSTRUMENTS FOR THE RADIO AND ELECTRONIC INDUSTRY

FM SIGNAL GENERATOR *TYPE 202-B*

RF COVERAGE: 54—216 megacycles in two ranges; accuracy ±0.5%.
FM DEVIATION: Three ranges, 0—24 kc., 0—80 kc., 0—240 kc., continuously adjustable.
FM DISTORTION: Less than 2% at 75 kc. deviation.
AMPLITUDE MODULATION: One range, 0—50%; calibrations at 30% and 50% modulation.
INTERNAL MODULATING FREQUENCIES: Eight frequencies from 50 cycles to 15 kc.
RF OUTPUT: 0.1 microvolt to 0.2 volt, continuously adjustable by means of 26.5 ohm piston type attenuator.

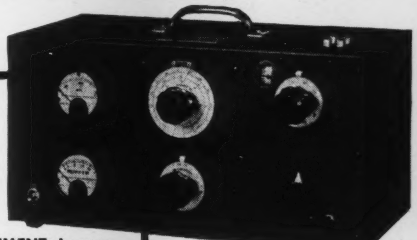
UNIVERTER *TYPE 207-A*

An FM-AM frequency converter accessory with unity gain for use with 202-B FM Signal Generator.
RF RANGE: 0.1 mc. to 55 mc.
RF INCREMENT DIAL: ±300 kc. in 5 kc. increments.
RF OUTPUT: 0.1 microvolt to 0.1 volt, calibrated output (26.5 ohms); 1.5 volts max., uncalibrated output (approx. 330 ohms).



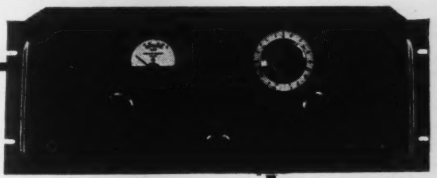
Q-METER *TYPE 160-A*

FREQUENCY RANGE: 50 kc. to 75 mc. (±1%, 50 kc.—50 mc.; ±3%, 50 mc.—75 mc.). May be extended down to 1 kc. with external accessory oscillator.
RANGE OF Q MEASUREMENTS, COILS: 50—625.
ACCURACY OF Q MEASUREMENT: In general, ±5%.
RANGE OF Q TUNING CAPACITOR: Main Section, 30—450 mmf. (±1% or ±1 mmf., whichever is greater). Vernier Section, plus 3, zero, minus 3 mmf., (±0.1 mmf.).



Q-METER *TYPE 170-A*

FREQUENCY RANGE: 30 mc. to 200 mc. (±1%).
RANGE OF Q MEASUREMENT: 80—1200.
ACCURACY OF Q MEASUREMENT: In general, ±10%.
RANGE OF Q TUNING CAPACITOR: 11—60 mmf. (±1% or ±0.5 mmf., whichever is greater).



GLIDE SLOPE TEST SET—*TYPE 212-A*

For use with Type 211-A Signal Generator to test Glide Slope Receivers.
RF FREQUENCY RANGE: 329 mc. to 335 mc.
Output: Same as 211-A ±1 db—Variations in output for constant input indicated.
Output Impedance: 53 ohms unbalanced.
IF FREQUENCIES: 20.700 mc., 20.400 mc., 21.000 mc. crystal controlled.
Output: 1 microvolt to 1 volt across 53 ohms unbalanced.
AM Modulation available.

OMNI RANGE

SIGNAL GENERATOR *TYPE 211-A*

FREQUENCY RANGE: 88-140 megacycles in one range. Also two crystal controlled frequencies: 110.100 and 114.900 mc., each accurate to ±0.0035%.
AMPLITUDE MODULATION: Two ranges, 0-30% and 0-100%. Fidelity ±0.5 db., 30 cycles to 11 kc.
INTERNAL AUDIO OSCILLATOR: Two modulating frequencies, 400 and 1000 cycles.
PHASE DISTORTION: Less than 0.25 degrees at 30 cycles up to 60% AM.
OUTPUT VOLTAGE: 0.2 volts maximum across 26.5 ohms.

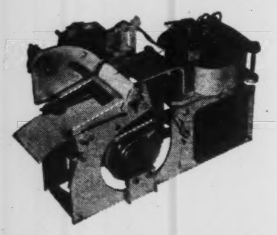
Write for further information

BOONTON RADIO *Corporation*
BOONTON · N · J · U · S · A

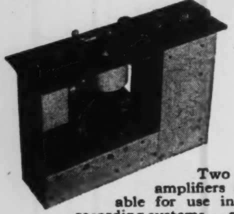
SANBORN

RECORDING SYSTEMS

RECORDERS AND AMPLIFIERS AVAILABLE SEPARATELY

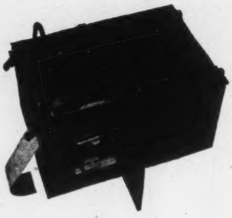


In all Sanborn recorders, tracings are produced by a heated writing stylus in contact with heat sensitive, plastic-coated paper. The paper is pulled over a sharp edge in the paper drive mechanism, and the stylus wipes along this edge as it swings; thus producing records in true rectangular coordinates. The writing arm is driven by a D'Arsonval moving coil galvanometer with extremely high torque movement (200,000 dyne cm/cm deflection). Standard paper speed for the Model 51-600 recorder assembly, shown above, is 25 mm/sec. Slower speeds are available. Paper width 6 cm with 5 cm recording area. The assembly shown above is used in Models 128 and 141 (described above right) and provides the basic principles and methods on which recorders for the 2- and 4-channel systems are designed.



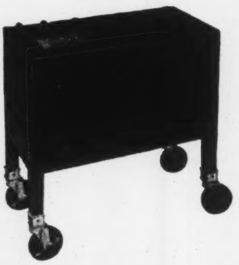
Two types of amplifiers are available for use in Sanborn recording systems — a DC General Purpose Amplifier, and a Strain Gage amplifier (shown above). The amplifiers used in the 2- and 4-channel systems are generally identical with those in the 1-channel system, which are available, as are also all the recorders, for separate application.

1 CHANNEL RECORDING SYSTEMS



Model 128 comprises a DC General Purpose Amplifier in combination with the Recorder Assembly shown below left, to which is added panel, transformer, and controls. Both instruments are contained in a single hardwood carrying case. The complete system is a vacuum tube recording voltmeter capable of reproducing in rectangular coordinates any electrical phenomena from the order of a few millivolts to more than 200 volts. When a Strain Gage Amplifier is specified, the system becomes Model 141. Amplifiers are readily interchangeable. When a built-in timer is included for either, the Model numbers become 128T or 141T.

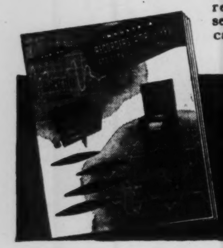
2 CHANNEL RECORDING SYSTEMS



The two channels of **Model 60** operate independently of each other, but record simultaneously. Ten paper speeds are standard equipment, in pairs of: 5 and 0.5, 10 and 1, 25 and 2.5, 50 and 5, 100 and 10 mm/sec. Ready interchangeability of amplifiers (DC and Strain Gage) and preamplifiers (DC and AC) makes possible the availability of a variety of input circuits. Timing and coding are built-in features. Each channel has a 5 cm recording width.

4 CHANNEL RECORDING SYSTEMS

Model 67 provides for the direct, simultaneous registration of up to four phenomena on one record, using the same principles and methods as the two systems described above. In addition, there is a selection of eight paper speeds: 50, 25, 10, 5, 2.5, 1.0, 0.5, and 0.25 mm/sec., and provision for the use of 4-, 2-, or 1-channel recording Permapaper. As in Model 60, above, amplifiers and preamplifiers are readily interchangeable.



For complete descriptions, illustrations, tables of constants, and prices, write for catalog.

INDUSTRIAL DIVISION
Sanborn Company
CAMBRIDGE 39, MASSACHUSETTS

Fairchild Recording
Magnecard, Inc.
Presto Recording
R.C.A.

RECORDERS (See object of measurment and control)

RECTIFIERS, Dry Disk
Automatic Elec. Chicago
Birtcher Corp.
Bradley Labs.
Conant Laboratories
Control Corp.
Dearborn Scientific
De Jur-Amsco Corp.
Elec. Facilities, Inc.
Federal Telephone
General Elec. Co.
International Rectifier Corp.
La Marche
Mallory & Co.
Radio Receptor Co.
Raytheon Mfg. Co.
Richardson-Allen
Schauer Mfg. Co.
Standard Elec. Time
Standard Transformer
Sylvania Elec. Prod.
Vickers Electric
Westinghouse Elec.

RECTIFIERS, Mercury Vapor
Eitel McCullough
Federal Telephone

RECTIFIERS, Power
Airdesign, Inc.
Allis-Chalmers
American Communications
American Transformer
Amplifier Co.
Applied Research Labs.
Automatic Elec.
Birtcher Corp.
Bradley Labs.
Continental Electric
Cutler-Hammer, Inc.
Eclipse Aviation
Eitel McCullough
Elec. Facilities Inc.
Electro Products Labs.
Electronic Labs. Inc.
Electronic Products
Electrons, Inc.
Electro-Tech Equip.
Federal Telephone
Furst Electronics
General Elec. Co.
Huggins Labs.
Mallory & Co.
Raytheon Mfg. Co.
RCA
Richardson-Allen
Schauer Mfg. Co.
Vickers Electric
Westinghouse Elec.

RECTIFIERS, Thermionic
American Communications
Amplifier Co.
Atomic Instrument
Automatic Elec. Chicago
Birtcher Corp.
Communication Meas. Lab.
Continental Elec. Co.
Dearborn Scientific
DuMont Labs., Inc., A. B.
Electro Products Labs.
Electronic Products
Electrons, Inc.
Federal Telephone
Furst Electronics
General Elec. Co.
Process & Instruments
Raytheon Mfg. Co.
RCA Division
Richardson-Allen
Sylvania Elec. Prod.

REDUCING MOTIONS, ENGINE INDICATOR
Bacharach Indust. Inst.
Crosby Steam Gage Co.
Trimount Inst. Co.

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REFLECTOMETERS
American Inst. Co.
Beckman Instruments
Dearborn Scientific
Fish-Schurman Corp.
Gardner Laboratory
General Electric
Instrument Dev. Labs.
Leeds & Northrup Co.
Pfaltz & Bauer
Photovolt Corp.

REFLECTORS, Aspherical
American Lens Co.
Baird Associates
Bausch & Lomb Optical
Buchele, W.
Fecker, J. W.
Fish-Schurman Co.
Geophysical Inst. Co.
Howland Optical
Ice Optical Co., H. C.
Lancaster Lens
Mann Co., W. I.
Optron Laboratory
Palos Optical Co.
Perkin-Elmer Corp.
Simpson Optical Mfg.
Tinsley Labs.
Unertl Optical Co.
Zenith Optical

REFLECTORS, Concave
American Lens Co.
Baird Associates
Bausch & Lomb Optical
Bray Optical
Buchele, W.
Cal-Astro Optical
Clark & Sons
Curtiss Labs.
Dome Precision
E & S Optical
(Continued)
Eclipse-Pioneer
Fecker, J. W.
Fish-Schurman Co.
Gaertner Scientific
Geophysical Inst. Co.
Hayward Scientific Glass
Henson Co., Fred C.
Herron Optical
Howland Optical Co.
Ice Optical Co., H. C.
International Glass
Lancaster Lens
Mann Co., W. I.
Optron Laboratory
Pacific Optical
Palos Optical Co.
Penn Optical & Inst.
Perkin-Elmer Corp.
Simpson Optical Mfg.
Tinsley Labs.
Unertl Optical Co.
Zenith Optical

REFLECTORS, First Surface
American Lens
Baird Associates
Bausch & Lomb Optical
Bray Optical Co.
Buchele, W.
Cal-Astro Optical
Clark & Sons
Crystal Research Labs.
Curtiss Labs.
Dearborn Scientific
Dome Precision
E & S Optical
Fecker, J. W.
Fish-Schurman Co.
Gaertner Scientific
Geophysical Instrument
Hayward Scientific Glass
Henson Co., Fred C.
Herron Optical
Howland Optical Co.
Ice Optical Co., H. C.
International Glass
Laboratory Specialties
Lancaster Lens
Mann Co., W. I.
Optron Laboratory
Pacific Optical
Pacific Univ. Prod.
Palos Optical Co.
Penn Optical & Inst.
Perkin-Elmer Corp.
Simpson Optical Mfg.
Tinsley Labs.
Unertl Optical Co.
Zenith Optical

REFLECTORS, Heat Resisting
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Bausch & Lomb Optical
Fecker, J. W.
Fish-Schurman Co.
Lancaster Lens
Mann Co., W. I.
Optron Laboratory
Palos Optical Co.
Perkin-Elmer Corp.
Simpson Optical Mfg.
Zenith Optical

REFLECTORS, Parabolic
American Lens
Baird Associates
Bausch & Lomb Optical
Buchele, W.
Clark & Sons
Farrand Optical
Fecker, J. W.
Fish-Schurman Co.
Gaertner Scientific
Howland Optical Co.
Ice Optical Co., H. C.
Lancaster Lens
Mann Co., W. I.
Optron Laboratory
Palos Optical Co.
Perkin-Elmer Corp.
Simpson Optical Mfg.
Tinsley Labs.
Unertl Optical Co.
Weber Bros. Metal Works
Zenith Optical

REFLECTORS, Spherical
American Lens
Baird Associates
Bausch & Lomb Optical
Bray Optical
Buchele, W.
Cal-Astro Optical
Curtiss Labs.
E & S Optical
Farrand Optical
Fecker, J. W.
Fish-Schurman Co.
Gaertner Scientific
Geophysical Inst. Co.
Hayward Scientific Glass
Henson Co., Fred C.
Herron Optical
Howland Optical Co.
Ice Optical Co., H. C.
International Glass
Lancaster Lens
Mann Co., W. I.
Optron Laboratory
Pacific Optical
Palos Optical Co.
Penn Optical & Inst.
Perkin-Elmer Corp.
Simpson Optical Mfg.
Tinsley Labs.
Unertl Optical Co.
Zenith Optical

REFLECTORS, Stellite
Acme Industrial
Bausch & Lomb Optical
Gaertner Scientific
Geophysical Inst. Co.
Kollmorgen Optical Co.
Mann Co., W. I.
Optron Laboratory
Perkin-Elmer Corp.
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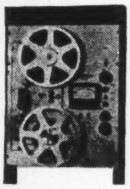

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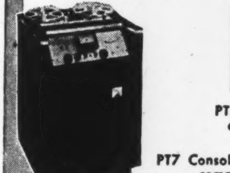

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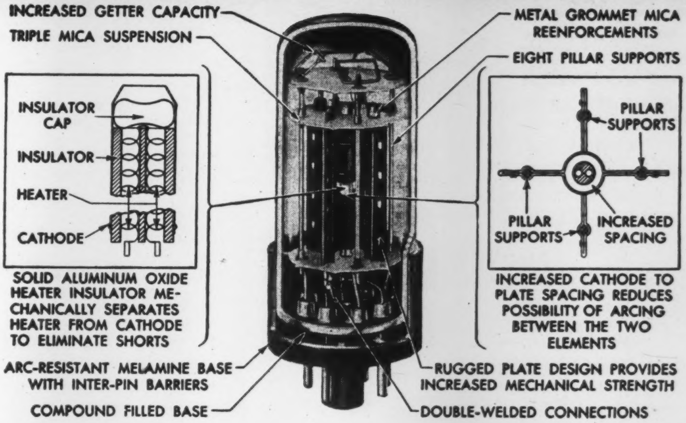
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ARC-RESISTANT MELAMINE BASE WITH INTER-PIN BARRIERS
RUGGED PLATE DESIGN PROVIDES INCREASED MECHANICAL STRENGTH
COMPOUND FILLED BASE
DOUBLE-WELDED CONNECTIONS

We are not in the standard vacuum tube business, but we are in the business of developing and manufacturing a reliable line of special purpose electron tubes—tubes that will serve and meet the stiff and varied operational requirements of aviation, ordnance, marine and other fields of modern industry. Typical of these are receiving type tubes such as Beam-Power Amplifiers, R-F Pentodes, Twin Triodes, and the Full-Wave Rectifiers illustrated above and described below. All of these tubes are exhausted on a special automatic exhausting machine capable of extra high evacuation, and are aged under full operating and vibration conditions for a period of 50 hours. In addition to the tubes described above, Eclipse-Pioneer also manufactures special purpose tubes in the following categories: gas-filled control tubes, Klystron tubes, spark gaps, temperature tubes and voltage regulator tubes.

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Electrical Characteristics of E-P Full-Wave Rectifier Tubes

TUBE TYPE	R.M.A. 5838	R.M.A. 5839	R.M.A. 5852	R.M.A. 5993
Heater Voltage	12 volts	26.5 volts	6.3 volts	6.3 volts
Heater Current	0.6 amps.	0.285 amps.	1.2 amps.	0.80 amps.
Peak Inverse Voltage	1375 v. (max.)	1375 v. (max.)	1375 v. (max.)	1250 v. (max.)
Peak Plate Current (per plate)	270 ma. (max.)	270 ma. (max.)	270 ma. (max.)	230 ma. (max.)
D-C Heater-Cathode Potential	450 v. (max.)	450 v. (max.)	450 v. (max.)	400 v. (max.)
Cathode Heating Time	1 min.	1 min.	1 min.	45 sec.
Total Effective Plate Supply Impedance	150 ohms (min.)	150 ohms (min.)	150 ohms (min.)	150 ohms (min.)

Other E-P precision components for servo mechanism and computing equipment:

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Condenser Testing
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Geiger-Muller Counters
Guided Missile Circuits
Inverse Peak Suppressors
Oscilliscopes
Photo-Flash Power Supplies
Radar Circuits
Television Circuits

In Triple X Phenolic Tube with nickel-plated brass ferrule at each end for insertion in standard 30-ampere Fuse Clips. 9/16" diameter. Length from 1 3/32" to 9", depending on DC output voltage rating. Half-wave.

TYPE V-HF SERIES
5 milliamperes DC

PARTIAL LIST OF V-HF SERIES AVAILABLE

DC Output Volts	Rectifier Part No.	DC Output Volts	Rectifier Part No.	DC Output Volts	Rectifier Part No.
20	V1HF	100	V5HF	800	V40HF
40	V2HF	200	V10HF	1000	V50HF
60	V3HF	400	V20HF	3000	V150HF
80	V4HF	600	V30HF	4000	V200HF

Half-Wave. In 9/16" phenolic tube with pigtail leads. Overall length varies from 25/32" to 9", depending on DC output voltage rating.

TYPE Y-HP SERIES
11 milliamperes DC

PARTIAL LIST OF Y-HP SERIES AVAILABLE

DC Output Volts	Rectifier Part No.	DC Output Volts	Rectifier Part No.	DC Output Volts	Rectifier Part No.
20	Y1HP	200	Y10HP	1000	Y50HP
60	Y3HP	400	Y20HP	2000	Y100HP
80	Y4HP	600	Y30HP	3000	Y150HP
100	Y5HP	800	Y40HP	4000	Y200HP

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It's built especially for dead end (no flow) service . . . and guaranteed to be free from "drift" errors. Ranges 0-5; 0-25; 0-50; 0-125 psi for inlet pressures to 150 psi.

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Jarrell-Ash Co.
Optical Service & Dev.
Photovolt Corp.
Polarizing Instrument
Precision Scientific
Process & Instruments
Zeiss, Inc., Carl

REFRACTORY TUBES
Burrell Technical Supply
Minneapolis-Honeywell
Coors Porcelain Co.
Minneapolis-Honeywell
Wheatstone Corp.

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AiResearch Div.
American Meter Co.
Arca Regulators, Inc.
Askania Regulator Co.
Assoc. Valve & Engrg.
Atlas Valve Co.
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Automatic Temp. Control
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Block Mfg. Co.
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Boylston Co.
Bristol Co.
Brooke Eng. Co
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Clark Cooper Co.
Conoflow Corp.
Cutler-Hammer, Inc.
Davis Reg. Co.
Detroit Lubricator
Fischer & Porter
Fisher Governor Co.
Foster Engg. Co.
(Continued)
Foxboro Co.
Friez Instrument Div.
Fulton Sylphon Div.
General Controls
General Elec. Co.
Grove Regulator
Hagan Corp.
Hammel-Dahl Co.
Hays Corp.
H-B Instrument
Hoke, Inc.
Ideal Lab. Tool
Instrument Rep. & Mfg.
Johnson Service Co.
Kieley & Mueller
Klipfel Mfg.
Lammert & Mann Co.
Leslie Co.
Linde Air Products Co.
Manning, Maxwell & Moore
Mason Neilan Regulator
McAlear Mfg.
Mercoid Corp.
Mercon Regulator Co.
Minneapolis-Honeywell
Moore Products
Northern Equip. Co.
Partlow Corp.
(Continued)
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Preferred Utilities Mfg.
Republic Flow Meters
Reynolds Gas Regulator
Sampsel Time Control
Schade Valve Mfg.
Schutte & Koerting
Seely Inst. Co.
Shallcross Controls
Sprague Meter Co.
Spence Engineering Co.
Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
White-Rodgers Electric

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AiResearch Div.
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Black, Sivals, Bryson
Cash Co.
Foster Engineering
Foxboro Co.
General Controls
Hagan Corp.
Hammel-Dahl Co.
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Powers Regulator Co.
Vapor Recovery Systems

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Atlas Valve Co.
Bailey Meter Co.
Black, Sivals, Bryson
Brooke Eng. Co.
Campbell Co., J. A.
Cash Co.
Defender Inst. & Reg.
Douglass Automatic
Fisher Governor Co.
Foster Engg. Co.
Foxboro Co.
Fuel Watchman
General Controls
General Power Plant
General Regulator Corp.
Hagan Corp.
Hammel-Dahl Co.
Hays Corp.
Henszey Co.
Leeds & Northrup
Magnetrol
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator
Minneapolis-Honeywell
Perfex Corp.
Republic Flow Meters
Ruggles-Klingemann
Shallcross Controls
Tagliabue Div.
White Rodgers Elec.

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Askania Regulator Co.
Bailey Meter Co.
Bastian-Blessing
Block Mfg. Co.
Bristol Co.
Brooke Eng. Co.
Cash Co.
Conoflow Corp.
Electrimatic Corp.
Fischer & Porter
Fisher Governor Co.
Foster Engineering
Foxboro Co.
Frick Co.
General Controls
Grove Regulator
Hammel-Dahl Co.
Hays Corp.
Hoke, Inc.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.
Moore Products
Natural Gas Equipment
Republic Flow Meters
Reynolds Gas Regulator
(Continued)
Robertshaw Thermostat
Schade Valve Mfg. Co.
Shallcross Controls
Tagliabue Div.
Vapor Recovery Systems

REGULATORS, AUTOMATIC, Condensation (See Controllers, Automatic, Condensation)

REGULATORS, AUTOMATIC, Consistency (Paper & Pulp) (See Controllers, Automatic, Consistency)

REGULATORS, AUTOMATIC, Current
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Amperite Corp.
Amplifier Co.
Askania Regulator Co.
Automatic Elec. Chicago
Automatic Temp. Control
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Betts & Betts
Bradley Laboratories
Burlington Inst. Corp.
Clarostat Mfg. Co.
Cook Electric
Cutler-Hammer, Inc.
DoAll Co.
Doelcam Corp.
Eclipse-Pioneer Div.
Electric Regulator
Furst Electronics
General Controls
General Elec. Co.
Hagan Corp.
Lewis & Co., J. B.
Lindberg Engineering
Nankervis Co., G. L.
Raytheon Mfg. Co.
Rockwell Engr.
Roller-Smith
Rubicon Co.
Sherron Metallic
Sola Electric Co.
Sorensen & Co.
Thermo Electric Mfg.
Thordarson Elec. Mfg.
Westinghouse Elec.
Wheelco Instruments
Wilson & Co., G. C.

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REGULATORS, AUTOMATIC, District (See Governors, District)

REGULATORS, AUTOMATIC, Draft (See Controllers, Automatic, Draft)

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Powers Regulator Co.
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REGULATORS, AUTOMATIC, Flow (See Controllers, Automatic, Flow)

REGULATORS, AUTOMATIC, Flow Proportioning (See Controllers, Automatic, Flow Proportioning)

REGULATORS, AUTOMATIC, Fluid Proportioning (See Controllers, Automatic, Fluid Proportioning)

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Magnetic Amplifiers
Metrotype Corp.
Robinette Co.
Telechron, Inc.
Westinghouse Elec.
Wheelco Inst. Co.

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REGULATORS, AUTOMATIC, Gas (See Regulators, Automatic, Air)

REGULATORS, AUTOMATIC, Humidity (See Controllers, Automatic, Humidity)

REGULATORS, AUTOMATIC, Liquid Level (See Controllers, Automatic, Liquid Level)

REGULATORS, AUTOMATIC, Lead
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Hays Corp.
Lear, Inc.
Leeds & Northrup
Leslie Co.
Mosher Electronic
Norcross Corp.
Robinette Co., W. C.
Sorenson & Co.
Taylor Inst. Cos.
Westinghouse Elec.
Wilson & Co., G. C.

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Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Brooke Engineering
Brooks Rotameter
Cash Co.
Fischer & Porter
Fisher Governor
Foster Engg. Co.
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Hagan Corp.
Hammel-Dahl Co.
Hays Corp.
Lammert & Mann Co.
Leslie Co.
Lumenite Electronic
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Republic Flow Meters
Sampsel Time Control
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Clarke Inst. Corp.
General Controls
General Electric
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General Controls
Leeds & Northrup Co.
Robinette Co.
Shallcross Controls
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Arca Regulators, Inc.
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Atlas Valve Co.
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Leslie Co.
Lumenite Electronic
Mason-Neilan Regulator
McAlear Mfg.
Mercon Regulator Co.
Northern Equip. Co.
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Sampsel Time Control
Schade Valve Mfg. Co.
Spence Engineering Co.
Squires Co.
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Automatic Elec. Mfg. Co.
Burlington Inst. Co.
Control Corp.
Counter & Control Corp.
Cutler-Hammer, Inc.
Eclipse Pioneer
General Controls
General Electric
Lear, Inc.
Robinette Co.
Shallcross Controls
Westinghouse Elec.

REGULATORS, AUTOMATIC, Temperature (See Controllers, Automatic, Temperature)

REGULATORS, AUTO MATIC, Time (See Controllers, Automatic, Time)

REGULATORS. Automatic, Tarque
Askania Regulator
Vectron, Inc.

REGULATORS, AUTOMATIC, Vacuum (See Controllers, Automatic, Pressure & Vacuum)

REGULATORS, AUTOMATIC, Viscosity (See Controllers, Automatic, Viscosity)

REGULATORS, AUTOMATIC, Voltage
Allis-Chalmers
American Transformer
Amperite Corp.
Amplifier Co.
Askania Regulator Co.
Automatic Elec. Chicago
Beck Co.
Boonton Radio Corp.
Bradley Laboratories
Burlington Inst. Corp.
Clarostat Mfg. Co.
Clippard Inst. Lab.
Collins Radio Co.
Commercial Research
Communication Meas. Lab.
Control Corp.
Doelcam Corp.
Eclipse-Pioneer
Electronic Associates
El-Tronics, Inc.
Federal Telephone
Ferris Inst. Corp.
Fredericks, George
Furst Electronic
General Elec. Co.
Hastings Instrument
International Resistance
Kellogg Switchboard
Laboratory for Electronics
La Marche
Lewis & Co., J. B.
Magnetic Amplifiers
Miller Co., Bertrand F.
Nuclear Inst. & Chem.
Oregon Electronic
Polarad Electronics
Process & Instruments
Raytheon Mfg. Co.
Reliance Instrument
Richardson-Allen
Rockwell Engr.
Sherron Metallic
Sola Electric Co.
Sorensen & Co.
Superior Electric
Sylvania Elec. Prods.
Thordarson Elec. Mfg.
United Transformer Corp.
Walkirt Co.
Ward Leonard Elec. Co.
Westinghouse Elec.
Wheelco Instruments
Wilson & Co., G. C.
Yellow Spring Inst. Co.

REGULATORS, AUTOMATIC, Water Pressure (See Controllers, Automatic, Pressure)

REGULATORS, AUTOMATIC, Welding, Gas
Bastian-Blessing Co.
Cutler Hammer, Inc.
Grove Regulator
Hoke, Inc.
Linde Air Products

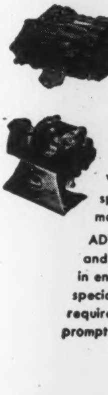
RELAYS, Automatic
Adams & Westlake
Advance Elec. & Relay
Allen-Bradley Co.
American Inst. Co.
American Relay & Controls
Amperite Co.
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Temp. Control
Beck Co.
Clare & Co.
Climax Div.
Cook Electric Co.
Cramer Co., Inc.
Cutler-Hammer, Inc.
Eastern Industries
Eclipse-Pioneer
Edison, Inc., Thomas
Esterline-Angus
General Controls Co.
General Elec. Co.
Guardian Elec. Mfg. Co.
Hagan Corp.
H-B Instrument
Industrial Eng. Corp.
Industrial Timer Corp.
Kellogg Switchboard
Mercoid Corp.
Minneapolis-Honeywell
Neomatic Inc.
Perfex Corp.
Phillips Control
Potter & Brumfield
Roller-Smith
Struthers-Dunn
Triplett Elec. Inst.
Ward-Leonard Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAYS, Capacity-Operated
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Temp. Control
Browning Labs.
Cook Electric
Electronic Lab.
Electro-Physics
El-Tronics, Inc.
Fielden Instrument
General Controls
General Electric
Lumenite Electronics
Potter & Brumfield
Struthers-Dunn
Thermo Instruments

RELAYS, Circuit Control
Adams & Westlake
Advance Elec. & Relay Co.
Allen-Bradley Co.
Allied Control Co.
American Inst. Co.
American Relay & Controls
Amperite Co.
Autocall Co.
Automatic Elec., Chicago
Automatic Elec. Sales
Automatic Switch Co.
Automatic Temp. Control
Beck Co.
Clare & Co.
Cook Electric Co.
Cutler-Hammer, Inc.
De-Tec-Tronics Labs.
Dorothea Mechanisms
Eastern Industries
Eclipe Pioneer
Edison Electrical Control
Federal Telephone
Friez Inst. Div.
General Controls
General Elec. Co.
H-B Instrument
Hufco Industries
Industrial Timer Corp.
Kellogg Switchboard
Leach Relay Co.
Lumenite Elec.
Miller Co., Bertrand F.

(Continued)

For
Advanced
RELAYS
specify
ADVANCE



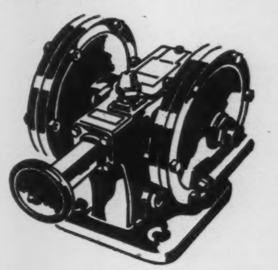
RELAYS for general circuit control, electronic, aircraft and marine applications. Crisp action, dependable and durable. ADVANCE offers sensitive, midget, midget telephone, keying, instrument, time-delay, overload, transmission line, impulse, hermetically sealed, and ceramic insulated relays. Wide variations of these types for special applications and special relays made to specifications.

ADVANCE'S engineering ability and manufacturing facilities will assist in engineering problems and supply special relays for the most exacting requirements. Your inquiry will receive prompt and courteous attention.

ADVANCE RELAYS

ADVANCE ELECTRIC & RELAY CO.
2435 North Noami St., Burbank, Calif.

Precision
REGULATORS



Askania Regulators assure exacting pressure, flow or proportioning control, through the operation of cylinders, valves, dampers or other mechanisms. Built around the exclusive Jet-Pipe Principle, Askania Regulators convert signals or impulses into extremely accurate proportionate movements of the mechanisms.

Full information available.

ASKANIA Controls

ASKANIA REGULATOR COMPANY
246 E. Ontario St., Chicago 11, Ill.
A Subsidiary of
General Precision Equipment Corporation

REPUBLIC
REGULATORS

Republic pneumatic or hydraulic type regulators are supplied for the automatic control of pressure, rate of flow, speed of rotation, liquid level, or the proportioning of two pressures, flows, etc., in a fixed ratio.

They measure the quantities they control regardless of the application. They can be made sensitive to changes of less than 0.002 in. of water.

WRITE FOR DATA BOOK No. S-13

REPUBLIC FLOW METERS CO.
2240 Diversey Pkwy. Chicago 47, Ill.

REPUBLIC
INSTRUMENTS • CONTROLS

Minneapolis-Honeywell
Neomatic Inc.
Perfex Corp.
Phillips Controls
Photoswitch
Precision Scientific
Potter & Brumfield
Roller-Smith
Sampsel Time Control
Shepard Labs.
Sigma Instrument, Inc.
Struthers-Dunn
Triplett Elec. Inst.
Ward Leonard Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAYS, Continuous Current

Adams & Westlake
Advance Elec. & Relay Co.
Allen-Bradley Co.
Allied Control Co.
American Inst. Co.
Arrow-Hart & Hegeman
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Sales
Automatic Switch
Automatic Temp. Control
Clare & Co.
Cook Electric Co.
Cutler-Hammer, Inc.
Eclipse-Pioneer
Esterline-Angus
General Controls
General Elec. Co.
Guardian Elec. Mfg. Co.
H-B Instrument
Industrial Timer Corp.
Kellogg Switchboard
Leach Relay Co.
Neomatic Inc.
Potter & Brumfield
Price Electric Corp.
Sigma Instruments
Struthers-Dunn
Triplett Elec. Inst.
Ward Leonard Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAYS, Control

Adams & Westlake
Advance Elec. & Relay Co.
Allen-Bradley Co.
American Inst. Co.
American Relay & Controls
Amperite Co.
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Sales
Automatic Temp. Control
Bailey Meter Co.
Barber-Colman
Beck Co.
Betts & Betts
Brown Inst. Div.
B. W. Controller Corp.
Clare & Co.
Control Corp.
Cook Electric Co.
Cutler-Hammer, Inc.
Dorothea Mechanisms
Eastern Industries
Eclipse-Pioneer
Edison, Inc, Thomas
Fisher-Pierce Co.
General Controls Co.
General Elec. Co.
Guardian Elec. Mfg. Co.
G-V Controls
Hagan Corp.
H-B Instrument
Industrial Eng. Corp.
Industrial Timer Corp.
Kellogg Switchboard
Leach Relay Co.
Miller Co., Bertrand F.
Minneapolis-Honeywell
National Time & Signal
Neomatic Inc.
Perfex Corp.
Phillips Control
Photoswitch, Inc.
Potter & Brumfield
Precision Scientific
Precision Therm.
Price Electric Corp.
Robinette Co., W. C.
Roller-Smith Co.
Sampsel Time Control
Sigma Instruments
Struthers-Dunn
Triplett Elec. Inst.
Ward Leonard Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.
White Rodgers Elec.

RELAYS, Current

Adams & Westlake
American Instrument
Betts & Betts
General Electric Co.
Guardian Electric
H-B Instrument
Neomatic Inc.
Perfex Corp.
Phillips Control
Potter & Brumfield
Roller-Smith
Sigma Instruments
Triplett Elec. Inst.
Ward Leonard
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAYS Demand Totalizing

Autocall Co.
Automatic Elec. Chicago
General Elec. Co.
Guardian Electric
Hagan Corp.
Westinghouse Elec.

RELAYS, Electromagnetic

Advance Elec. & Relay Co.
Allen-Bradley Co.
Allied Control Co.
American Inst. Co.
American Relay & Controls
Amperite Co.
Arrow-Hart & Hegeman
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg. Co.
Automatic Switch Co.
Bunnell & Co.
Control Corp.
Cook Electric Co.
Clare & Co.
Cutler-Hammer, Inc.
Doelcam Corp.
Eastern Industries
Eby, Inc.
Eclipse-Pioneer
Edison, Inc., Thomas A.
Engineering Res. & Dev.
Friez Instrument Div.
General Elec. Co.
G-M Labs.
Gorrell & Gorrell
Guardian Elec. Mfg. Co.
H-B Instrument
Hufco Industries
Industrial Eng. Corp.
Kellogg Switchboard
Leach Relay Co.
Miller Co., Bertrand F
Minneapolis-Honeywell
National Time & Signal
Neomatic Inc.
Penn Electric Switch Co.
Perfex Corp.
Phila. Thermometer Co.
Phillips Control
Potter & Brumfield
Precision Scientific
Precision Therm. & Inst.
Price Electric Corp.
Sigma Instruments, Inc
Stromberg Time Corp.
Struthers-Dunn
Tork Clock
Triplett Elec. Inst.
Ward Leonard Elec. Co.
Warrick Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.
White-Rodgers Electric

RELAYS, Electronic

Advance Elec. & Relay Co.
American Inst. Co.
Automatic Elec. Mfg.
Automatic Temp. Control
Beck Co.
Bell & Howell
Berkshire Laboratories
Central Scientific
Clare & Co., C. P.
Coleman Electric
Cook Electric
Cramer Co., Inc.
Cutler-Hammer, Inc.
Davis & Co., Inc., Dean
De-Tec-Tronics Labs.
Eclipse-Pioneer
Electro-Medical Lab
Electronic Dev. Lab.
Electro-Physics Co.
Engrg. Research & Dev.
Ess Instrument
Fisher-Pierce Co.
Fisher Scientific Co.
General Elec. Co.
Gorrell & Gorrell
Guardian Elec. Mfg.
Harvey Radio Labs.
H-B Instrument
Leach Relay Co
Lumenite Co.
Lyman Electronic
Minneapolis-Honeywell
Neomatic Inc.
Phillips Control
Phipps & Bird
Photoswitch, Inc.
Potter & Brumfield
Price Electric Corp.
Process & Instruments
RCA Div.
Robinette Co., W. C.
Rockwell Engr.
Sigma Instruments
Struthers-Dunn
Televiso Products
Thordarson Elec. Mfg.
Wilson & Co., G. C.

RELAYS, Frequency

Autocall Co.
Automatic Elec. Chicago
Automatic Switch Co.
Biddle Co.
Clare & Co., C. P.
Control Corp.
Cook Electric
Cutler-Hammer, Inc.
Eclipse-Pioneer
Esterline-Angus Co.
General Elec. Co.
Guardian Electric
Hickok Electrical Inst.
Kellogg Switchboard
Potter & Brumfield
Sigma Instruments
Stevens-Arnold Co.
Wallace & Tiernan
Ward Leonard Electric Co.
Westinghouse Elec.

RELAYS, Galvanometer

Assembly Products
Autocall Co.
Automatic Elec. Chicago
Automatic Temp. Control
Cole Instrument
Eby, Inc., Hugh H.
Esterline-Angus
Potter & Brumfield
Roller-Smith
Rubicon Co.
Tagliabue Div.

RELAYS, Heavy Duty

Adams & Westlake
Advance Elec. & Relay Co.
Allen-Bradley Co.
American Inst. Co.
American Relay & Controls
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Switch Co.
Automatic Temp. Control
Cook Electric
Cutler-Hammer, Inc.
Eclipse-Pioneer
Esterline-Angus
General Elec. Co.
H-B Instrument
Leach Relay Co.
Miller Co., Bertrand F.
Philadelphia Thermometer
Potter & Brumfield
Price Electric Corp.
Struthers-Dunn
Ward Leonard Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Zenith Electric Co.

RELAYS, Instrument Controlled

Adams & Westlake
Advance Elec. & Relay
American Inst. Co.
Assembly Products
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Temp. Control
Bailey Meter Co.
Barber-Colman
Beck Co.
Carter Radio Div.
Clare & Co.
Climax Div.
Cole Instrument
Cook Electric Co.
Cramer & Co., Inc.
Eclipse-Pioneer
Electric Des. & Mfg.
Friez Instrument Div.
General Elec. Co.
Guardian Elec. Mfg. Co.
H-B Instrument
Minneapolis-Honeywell
Neomatic Inc.
Perfex Corp.
Phila. Thermometer Co.
Potter & Brumfield
Precision Scientific
Precision Therm.
Roller-Smith Co.
Sigma Instruments
Struthers-Dunn
Tagliabue Div.
Tork Clock
Triplett Electrical Inst.
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.

RELAYS, Light Sensitive (See Photoelectric below)

RELAYS, Magnetic (See Relays, Electromagnetic)

RELAYS, Mercury

Adams & Westlake
American Inst. Co.
Autocall Co.
Automatic Elec. Chicago
Automatic Temp. Control
Continental Elec. Co.
Durakool, Inc.
Ebert Electronics
Electronic Apparatus
Guardian Electric
H-B Instrument
Potter & Brumfield
Precision Scientific
Precision Therm.
Struthers-Dunn
Weston Elec. Inst. Corp.

RELAYS, Mercury Tube

Adams & Westlake
American Inst. Co.
Autocall Co.
Automatic Elec. Chicago
Automatic Temp. Control
Clare & Co.
General Controls Co.
G-M Labs.
Guardian Elec. Mfg. Co.
H-B Instrument
Kellogg Switchboard
Mercoid Corp.
Minneapolis-Honeywell
Phila. Thermometer
Potter & Brumfield
Precision Scientific
Precision Therm.
Struthers-Dunn
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.

RELAYS, Motor Driven Time Delay

Advance Elec. & Relay Co.
Allen-Bradley Co.
American Inst. Co
Automatic Elec. Mfg.
Barber-Colman
Betts & Betts
Clarostat Mfg. Co.
Controls, Inc.
Cramer Co., Inc.
Eagle Signal Co.
Friez Instrument
General Controls
General Electric
Guardian Electric
Haydon Co., A. W.
Industrial Eng. Corp.
Industrial Timer
Lumenite Electronics

(Continued)

Paragon Electric Co.
Potter & Brumfield
Price Electric Co.
Struthers-Dunn
Ward Leonard Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Zenith Electric Co.

RELAYS, Movable Coil A.C.

Advance Elec. & Relay
Automatic Elec. Mfg.
Electro-Tech. Equip.
Esterline-Angus Co.
General Elec. Co.
Roller-Smith Co.
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAYS, Overload

Adams & Westlake
Advance Elec. & Relay Co.
Allen-Bradley Co.
American Relay & Controls
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Switch Co.
Automatic Temp. Control
Bunnell & Co.
Burlington Inst. Corp.
Clare & Co.
Cook Electric
Cutler-Hammer, Inc.
Edison, Instrument Div.
General Elec. Co.
Guardian Elec. Mfg. Co.
Leach Relay Co.
Potter & Brumfield
Price Electric Corp.
Roller-Smith Co.
Sigma Instruments
Standard Elect. Prods.
Struthers-Dunn
Ward-Leonard Elec. Co.
Westinghouse Elec.

RELAYS, Permanent Magnet Movable Coil

Assembly Products
Bunnell & Co.
Cole Instrument
Electric Des. & Mfg.
Esterline-Angus Co.
General Elec. Co.
Guardian Electric
Roller-Smith Co.
Triplett Electrical Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAYS, Photoelectric

Advance Elec. & Relay Co.
American Inst. Co.
Automatic Temp. Control
Autotron Co.
Clare & Co.
Continental Elec. Co.
Cutler-Hammer, Inc.
Detect-O-Ray
De-Tec-Tronic Labs.
Dickson Co.
Eby, Inc.
Electro-Physics Co.
Electronic Controls
Electronic Dev. Lab.
El-Tronics, Inc.
Engrg. Research & Dev.
Ess Instrument Co.
Fisher-Pierce Co.
General Controls Co.
General Elec. Co.
Gorrell & Gorrell
Guardian Electric
Leach Relay Co.
Lumenite Elec.
Phillips Control
Phipps & Bird
Potter & Brumfield
Potter Instrument
Photoswitch, Inc.
Precision Therm.
Rockwell Engr.
Rubicon Co.
Sigma Instruments, Inc.
Tagliabue Div.
Triplett Elec. Co.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Polarized

Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Barber Colman
Bunnell Co., J. H.
Eclipse-Pioneer
General Electric
L. A. B. Corp.
Maxson Corp.
Miller Co., Bertrand F.
Neomatic Inc.
Precision Therm. & Inst.
Price Electric Corp.
Sigma Instruments
Stevens-Arnold Co.
Struthers-Dunn
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAY, Power

Advance Elec. & Relay Co.
Allen-Bradley Co.
American Inst. Co.
American Relay & Controls
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Switch Co.
Clare & Co.
Cutler-Hammer, Inc.
Detect-O-Ray
Eclipse-Pioneer
Esterline-Angus Co.
General Controls Co.
General Elec. Co.

(Continued)

Grayhill
Hagan Corp.
H-B Instrument
Leach Relay Co.
Phillips Control
Potter & Brumfield
Price Electric Corp.
Robinette Co., W. C.
Roller-Smith Co.
Struthers-Dunn
Ward Leonard Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

RELAYS, Power Factor

Advance Elec. & Relay Co.
Cutler-Hammer, Inc.
Esterline-Angus Co.
General Electric Co.
L. A. B. Corp.
Potter & Brumfield
Westinghouse Elec.

RELAYS, Resistance, D.C.

Advance Elec. & Relay Co.
American Relay & Controls
Autocall Co.
Automatic Electric Chicago
Bunnell & Co.
Clare & Co., C. P.
Cook Electric Co.
Cutler-Hammer, Inc.
Electro-Physics Co.
Esterline Angus
General Elec. Co.
Guardian Electric
Kellogg Switchboard
Leach Relay Co.
Neomatic Inc.
Potter & Brumfield
Price Electric Corp.
Sigma Instruments
Ward Leonard Elec. Co.

RELAY, Sounding

Leupold & Stevens

RELAYS, Stepping

Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Sales
Clare & Co.
Collins Radio Co.
Cook Electric
Dorothea Mechanisms, Gale
General Elec. Co.
G-M Laboratories, Inc.
Guardian Electric
Oak Mfg. Co.
Roller-Smith
Struthers-Dunn
Westinghouse Elec.

RELAYS, Telephone Auxiliary Ringing

Advance Elec. & Relay Co.
American Relay & Controls
Autocall Co.
Automatic Elec. Chicago
Clare & Co.
Cook Electric
Federal Telephone
Guardian Electric
Kellogg Switchboard
Leach Relay Co.
Phillips Control
Potter & Brumfield
Price Electric Corp.
Sigma Instruments
Struthers-Dunn

RELAYS, Temperature

Advance Elec. & Relay Co.
Assembly Products
Autocall Co.
Automatic Temp. Control
Clare & Co., C. P.
Cole Instrument
Cook Electric Co.
Edison Elec. Controls
Friez Instrument Div.
General Controls
General Elec. Co.
Gleason-Avery, Inc.
G-M Laboratories, Inc.
Guardian Electric
G-V Controls
H-B Instrument
Lewis Engineering
Leach Relay Co.
Minneapolis-Honeywell
Neomatic Inc.
Potter & Brumfield
Sampsel Time Control
Spencer Thermostat Co.
Struthers-Dunn
Tagliabue Div.
Triplett Elec. Inst.
Westinghouse Elec.
Weston Electrical Inst.

RELAYS, Temperature Compensated

Betts & Betts
Edison, Inc., Thomas
Fuel Watchman
Guardian Electric
Neomatic Inc.
Sigma Instruments
Wallace & Tiernan

RELAYS, Thermal Time Delay

Adams & Westlake
Advance Elec. & Relay Co
Allen-Bradley Co.
Am. Gas Accumulator
American Inst. Co.
American Relay & Controls
Amperite Corp.
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Temp. Control
Betts & Betts
Clare & Co.
Clarostat Mfg. Co.
Cook Electric Co.
Cramer Co., Inc.
Cutler-Hammer, Inc.
Eagle Signal Corp.

(Continued)

Edison, Inc., Thomas
Electronic Prod. Co.
Fisher-Pierce Co.
General Controls
General Elec. Co.
Guardian Elec. Mfg. Co.
G-V Controls
Industrial Eng. Corp.
Industrial Timer Corp.
Leach Relay Co.
Lumenite Electronics
Meletron Corp.
Partlow Corp.
Perfex Corp.
Photoswitch
Potter & Brumfield
Precision Therm.
Preferred Utilities Mfg.
Roller-Smith Co.
Sigma Instruments
Struthers-Dunn
Ulanet Co., Geo.
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.
Westinghouse Elec.
White-Rodgers Electric

RELAYS, Time Delay (See Relays. Thermal Time Delay

RELAYS, Transformer (Low Voltage)

Advance Elec. & Relay Co.
Allen-Bradley Co.
Auth Elec. Spec.
Automatic Electric Chicago
Barber-Colman
B. W. Controller Corp.
Friez Instrument Div.
General Controls Co.
General Elec. Co.
Gleason-Avery, Inc.
Guardian Elec. Mfg. Co.
H-B Electric
Industrial Eng. Corp.
Lumenite Electronics
Mercoid Corp.
Miller Co., Bertrand F.
Minneapolis-Honeywell
Partlow Corp.
Perfex Corp.
Potter & Brumfield
Sampsel Time Control
Sigma Instruments, Inc.
Struthers-Dunn
Thordarson Elec. Mfg.
Ward Leonard
Warrick Co.
Westinghouse Elec.
White-Rodgers Electric

RELAYS, Vaccum Contact

American Inst. Co.
Edison, Inc., Thomas
Eitel McCullough
General Elec. Co.
H-B Instrument
Lumenite Electronics
Rockwell Engr.
Skaneateles Mfg. Co.
Struthers-Dunn, Inc.

RELAYS, Vacuum Tube

Advance Elec. & Relay Co.
American Inst. Co.
Amperite Co.
Automatic Elec. Mfg.
Automatic Temp. Control
Berkshire Laboratories
Continental Elec. Co.
Eby, Inc.
Eclipse-Pioneer
Edison, Inc., Thomas
Electro-Medical Lab.
Electronic Dev. Lab.
Electronic Prod. Co.
El-Tronics, Inc.
Fisher-Pierce Co.
General Controls Co.
General Elec. Co.
Harvey Radio Labs.
H-B Instrument
Kellogg Switchboard
L. A. B. Corp.
Leach Relay Co.
Lumenite Electronics
Metron Instrument
Neomatic Inc.
Precision Therm.
Robinette Co., W. C.
Rockwell Engr. Co.
Sigma Instruments
Skaneateles Mfg. Co.
Struthers-Dunn
Sylvania Elec. Prods.
Tagliabue Div.
Wilson & Co.

RELAYS, Voltage

Adams & Westlake
Advance Elec. & Relay
Allen-Bradley Co.
American Relay & Controls
Amperite Co.
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Switch Co.
Barber-Colman
Clare & Co., C. P.
Cook Electric
Cutler-Hammer, Inc.
Eby, Inc., Hugh H.
Eclipse-Pioneer
Esterline-Angus Co.
Ferranti Electric, Inc.
General Controls
General Elec. Co.
Guardian Electric
G-V Controls
Hart Manufacturing Co.
Hathaway Inst. Co.
Leach Relay Co.
Lumenite Electronic
Neomatic Inc.
Philips Control
Potter & Brumfield
Reliance Instrument Co.

(Continued)

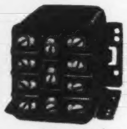
GUARDIAN

QUALITY Controls

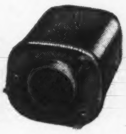
RELAYS . . .

HERMETICALLY SEALED

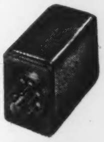
A. N. CONNECTOR



SCREW TERMINAL



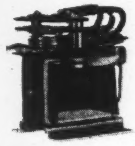
LUG HEADER



OCTAL PLUG

OPEN TYPE CONSTRUCTION

Series 120 A. C.

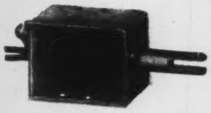


Series 345 D. C.

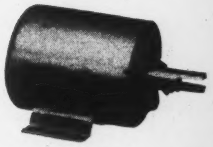
Series 595 D. C.

. . . SOLENOIDS

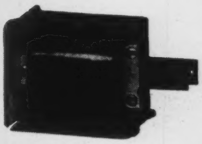
No. 1A A. C.



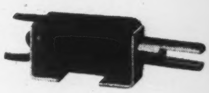
No. 4 A. C.



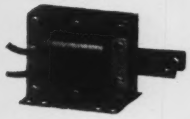
No. 7 D. C.



No. 14 A. C.



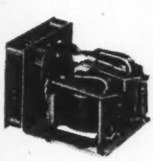
No 1A D. C.



No. 12 A. C.

STEPPERS

Series R



Series M. E. R.

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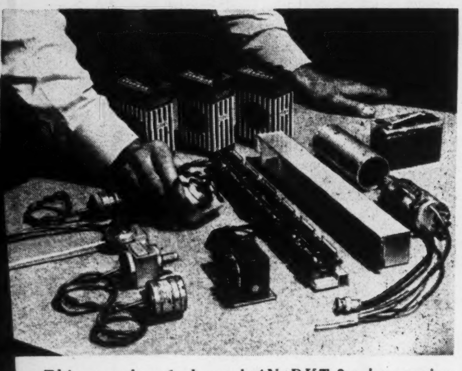

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INSTALLATION...

Supervision of initial installation.

FLIGHT TESTING...

Flight testing, reduction and analysis of data.

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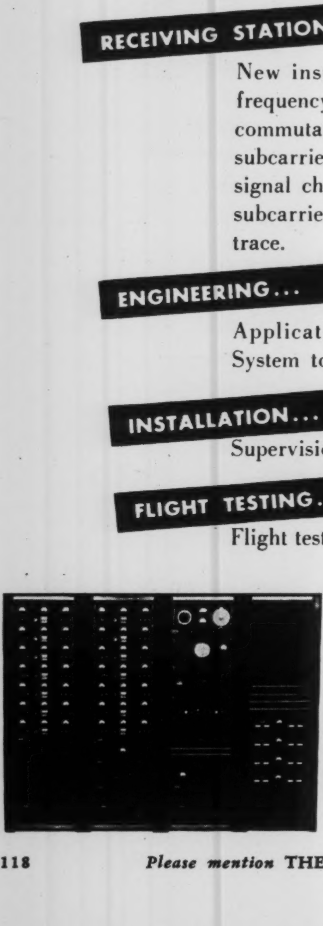

Photo at left shows typical 14 band Bendix Receiving Station.

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Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

TO MEASURE..TO WARN..TO INDICATE..AT A DISTANCE

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Triplett Electrical Inst.
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Westinghouse Elec.
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Magnetic Amplifiers
Minneapolis-Honeywell
Stewart Mfg. Corp.

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Automatic Temp. Control
Bristol Co.
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Clarke Inst. Corp.
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Control Corp.
Elec. Tachometer Corp.
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Electronic Associates
Engrg. Research & Dev.
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Farnsworth Television
Fielden Instrument
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Flader, Inc., Fredric
Foxboro Co.
General Elec. Co.
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Hathaway Inst. Co.
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Pioneer Instrument
Polarad Electronics
Rahm Instruments
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Yardeny Engineering

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Farris Engg. Corp.
Leupold & Stevens
Mason-Neilan Regulator
Pacific Div.
Servo Corp. of America
Skaneateles Mfg. Co.
Smith Meter Co.
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Bristol Co.
Brooks Rotameter
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Conoflow Corp.
Emery Co., A. H.
Farris Engg. Corp.
Fischer & Porter
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Hagan Corp.
Haydon Co., A. W.
Mason-Neilan Regulator
Minneapolis-Honeywell
Moore Products
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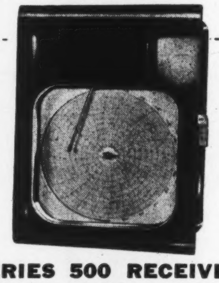

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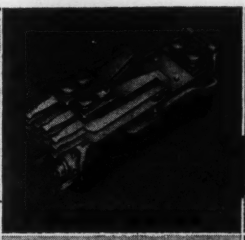
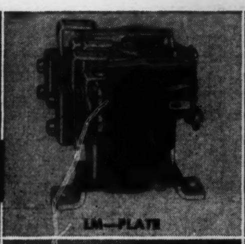

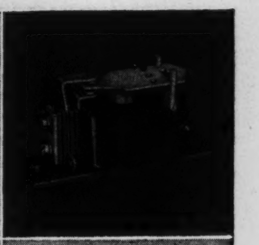
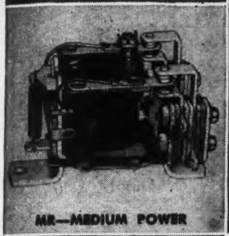

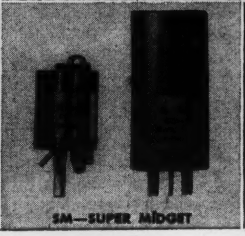

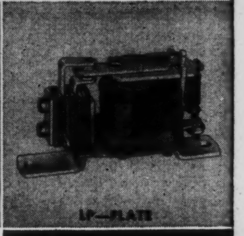

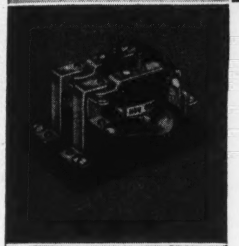
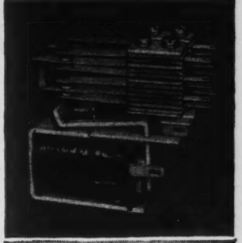

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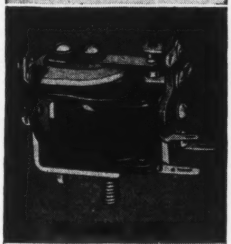

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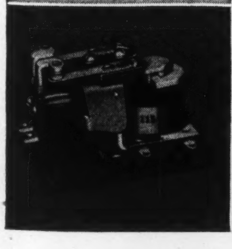
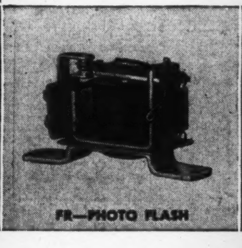
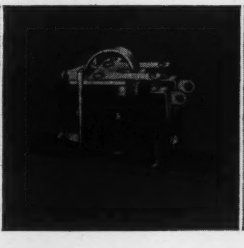
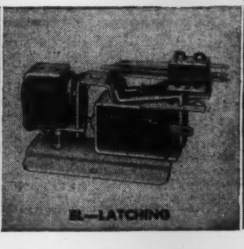
M CAN—14 PRONG PLUG



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Precision Wire-wound
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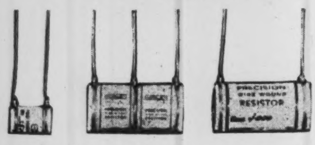

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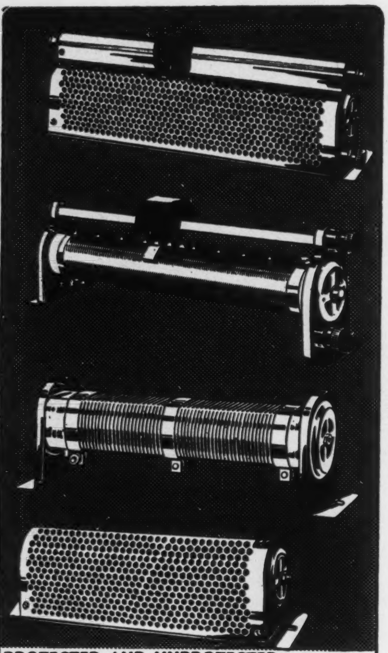

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Daven Co.
De Jur-Amsco
Electro-Mec Lab.
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Hardwick, Hindle, Inc.
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Mepco
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National Electric Control

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Borg Corp.
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Daven Co.
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Eastern Specialty Co.
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Mallory & Co.
Natl. Elec. Controller
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Rex Rheostat Co.
Shallcross Mfg.
States Co.
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Borg Corp.
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ROTAMETERS (See Flowmeters, Area, Free Float Type)

RUBBER STOPPERS
Rhodes Metaline Co.

RULES, Adjustable Curve (See Drawing Instruments)

RULES, Aluminum
Bowen & Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Stratex Instrument Co.
Warren-Knight Co.

RULES, Brass
Bliss & Co.
Grammes & Sons
Lufkin Rule Co.
Mico Instrument Co.
Starrett Co.
Warren-Knight Co.

RULES, Caliper
American Measuring Inst.
Brown & Sharpe
Glogau & Co.
Lufkin Rule Co.
Millers Falls Co.
Starrett Co.
Warren-Knight Co.

RULES, Drafting Room (See Drawing Instruments)

RULES, Folding
Bliss & Co.
Dietzgen Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Post Co., Frederick
Speidel & Co.
Starrett Co.
Stratex Instrument Co.
Warren-Knight Co.
Weber Co.
White Co., **David**

RULES, Glass
Fish-Schurman Co.
Dusenberry Co.
Electronic Products
Engineers Specialty Div.
Glass Engraving Co.
Kontes Glass Co.
Mann Co., W. I.
Mico Instrument Co.
Palos Optical Co.
Phoenix Prec. Inst.
Scientific Glass App.

RULES, Parallel
American Meas. Insts.
Bliss & Co.
Dietzgen Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Negus, T. S. & J. D.
Palos Optical Co.
Speidel & Co.
Warren-Knight Co.
White Co., Inc.
Weber Co.

RULES, Precision Standard
Amer. Measuring Insts.
Bowen & Co.
Brown & Sharpe
Engineers Specialty Div.
Gaertner Scientific Corp.
Griswold Mfg. Co.
Lufkin Rule Co.
Starrett Co.

RULES, Shrinkage
Brown & Sharpe
Keuffel & Esser Co.
Lufkin Rule Co.
Speidel & Co.
Starrett Co.
Warren-Knight Co.
Weber Co.

RULES, Slide (See Drawing Instruments)

RULES, Stainless Steel
Stafford Co.
Starrett Co., L. S.

RULES, Steel
American Measuring Insts.
Bowen & Co.
Brown & Sharpe
Keuffel & Esser Co.
Lufkin Rule Co.
Mico Instrument Co.
Millers Falls Co.
Scherr Co., Inc.
Speidel & Co.
Starrett Co.
Warren-Knight Co.
Weber Co.

RULES, Wood
Henschel & Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Post Co., Frederick
Speidel & Co.
Warren-Knight Co.
Weber Co.

RUNNING TIME RECORDERS
Aero Instrument
Alden Products
American Time Prod.
Bristol Co.
Cincinnati Time Rec.
Cramer Co., Inc.
General Electric
Gorrell & Gorrell
Marion Electrical Inst.
Westinghouse Elec.

RUNNING TIME TOTALIZERS
Aero Instrument
Bristol Co.
Cincinnati Time Rec.
Cramer Co., Inc.
Dale Instruments
Elec. Tachometer Corp.

(Continued)

General Electric
Gorrell & Gorrell
Haydon Co., A. W.
Jaeger Watch Co.
Lumenite Electronic
Production Instrument
Serdex, Inc.
Standard Elec. Time

SACCHARIMETERS
Aloe Co., A. S.
Bausch & Lomb Opt.
Central Scientific Co.
Griebel Co.
Jarrell-Ash Co.
Kimble Glass
Moeller Instrument Co.
Precision Thermometer
Rieker Inst. Co.
Rudolph & Sons
Sargent & Co.
Trerice Co.
Weksler Thermometer

SACCHAROMETERS
Central Scientific Co.
Fleischhauer & Son
Griebel Co.
G. M. Mfg. Co., Inc.
H. B. Inst. Co.
Kimble Glass Co.
Moeller Instrument Co.
Precision Therm. & Inst.
Rascher & Betzold
Rieker Inst. Co.
Ruehfel Co.
Scientific Inst. Co.
Tagliabue Div.
Taylor Inst. Cos.
Testrite Instrument Co.
Trerice Co.
Wagner & Son
Weksler Thermometer

SALINITY INDICATORS
Bendix Marine Products
Central Scientific Co.
Engineering Labs., Inc.
Fleischhauer & Son
Gerin Corp.
G. M. Mfg. Co., Inc.
Griebel Co.
H-B Inst. Co.
Industrial Insts., Inc.
Instrument Lab.
J-B-L Instrument
Kahl Scientific **Inst.**
Leeds & Northrup Co.
Moeller Inst. Co.
Precision Therm. & Inst.
Rascher & Betzold
Rubicon Co.
Ruehfel Co.
Scientific Inst. Co.
Tagliabue Div.
Taylor Inst. Cos.
Thwing Albert Inst. Co.
Trerice Co.
Weksler Thermometer
Wagner & Son
Westinghouse Elec.

SALINOMETERS (See Salinity Indicators)

SAMPLER, Boiler Water
Hagan Corp.
Tagliabue Div.

SAMPLER, Oil
Braun Corp.
Central Scientific Co.
Hoke, Inc.
Johnston & Jennings Co.
Precision Scientific
Proportioneers, Inc.
Refinery Supply Co.
Scientific Glass Apparatus
Shand & Jurs
Vapor Recovery Systems

SAMPLERS, Oil Bottomhole
Coleman Inst. & Mfg.
Hoke, Inc.
Precision Scientific
Ruska Inst. Corp.

SAMPLER, Peat and Marl
Eberbach Corp.

SAMPLERS, Sewage
Builders-Providence
Central Scientific Co.
Precision Scientific
Scientific Glass Apparatus
Thwing-Albert Inst.

SAMPLERS, Silt
Central Scientific Co.
Instruments Corp.
Leupold & Stevens

SAMPLERS, Snow
Leupold & Stevens

SCALER, Geiger Muller (See Counters, Geiger Muller)

SCALES (See also object of Measurement and Control)

SCALES, Antimony Test
Howe Scale Co.
Seederer-Kohlbusch, Inc.
Troemner, Henry

SCALES, Automatic
Automatic Scale Co.
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co., Inc.
Merrick Scale Mfg. Co.
Monsell, J. R.
Porter, George K.
Richardson Scale Co.
Schaffer Poidometer Co.
Seedburo Equipment
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.
Wallace & Tiernan

SCALES, Bag Filling
Automatic Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
Jacobs Bros. Co.
Richardson Scale Co.
Seedburo Equipment
Toledo Scale Co.

SCALES, Basis Weight
Amthor Testing Inst. Co.
Becker Div., Christian
Buffalo Scale Co.
Cady & Co., E. J.
Exact Scale Co.
Howe Scale Co.
Seederer-Kohlbusch
Testing Machines, Inc.
Thwing-Albert Instrument
Toledo Scale Co.
Triner Sales Co.

SCALES, Bulk Weighing
Automatic Scale
Becker Div., Christian
Buffalo Scale Co.
Chatillon & Sons
Conoflow Corp.
Emery Co., A. H.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co., B. F.
Howe Scale Co.
Jacobs Bros. Co.
Merrick Scale Mfg.
Monsell, J. R.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALES, Cement Batching
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Checking
Becker Div., Christian
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Jacobs Bros. Co., Inc.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Classifying
Chatillon & Sons
Exact Weight Scale Co.
Jacobs Bros. Co., Inc.
Merrick Scale Mfg. Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Computing
Amthor Testing Inst.
Exact Weight Scale
Howe Scale Co.
International Bus. Mach.
Jacobs Bros., Inc.
Toledo Scale Co.
Triner Sales Co.

SCALES, Continuous Weighing
Automatic Scale
Buffalo Scale Co.
Builders-Providence
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Jacobs Bros. Co.
Jeffrey Mfg. Co.
Merrick Scale Mfg. Co.
Monsell, J. R.
Omega Machine
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Triangle Package Mach.
Wallace & Tiernan

SCALES, Conveyor
Builders-Providence
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Merrick Scale Mfg. Co.
Monsell, J. R.
Omega Machine
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Wallace & Tiernan

SCALES, Counting
Amthor Testing Inst. Co.
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Potter Instrument
Seederer-Kohlbusch
Toledo Scale Co.
Triner Sales Co.

SCALES, Crane
Baldwin Locomotive
Buffalo Scale Co.
Chatillon & Sons
Dillon & Co.
Emery Co., A. H.
Fairbanks, Morse & Co.
Howe Scale Co.
Toledo Scale Co.

SCALES, Dairy
Becker Div., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Humboldt Mfg. Co.
International Bus. Mach.
Jacobs Bros. Co.
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.
Troemner, Henry

SCALES, Differential
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Jacobs Bros. Co., Inc.
Monsell, J. R.
Thwing-Albert Instrument

SCALES, Drawing (See Drawing Instruments)

SCALES, Dump
Automatic Scale
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Toledo Scale Co.

SCALES, Dynamometer
Automatic Temp. Control
Baldwin Locomotive
Central Scientific Co.
Chatillon & Sons
Conoflow Corp.
Dillon & Co.
Emery Co., A. H.
Exact Weight Scale
Fairbanks, Morse & Co.
Hagan Corp.
Howe Scale Co.
Monsell, J. R.
Republic Flow Meters
Seederer-Kohlbusch, Inc.
Stoelting Co., C. N.
Taller & Cooper
Toledo Scale Co.

SCALES, Estimating
Exact Weight Scale Co.
Jacobs Bros. Co.
Seederer-Kohlbusch, Inc.
Troemner, Henry

SCALES, Grain & Seed Testing
Amthor Testing Inst. Co.
Automatic Scale Co.
Becker Div., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Cuthbert Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Fisher Scientific Co.
Gump Co.
Howe Scale Co.
Jacobs Bros. Co.
Richardson Scale Co.
Seedburo Equipment
Streeter-Amet Co.
Toledo Scale Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALES, Hopper
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
Jacobs Bros. Co.
Richardson Scale Co.
Seedburo Equipment
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Laboratory
Becker Div., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Chicago Apparatus Co.
Clay-Adams Co.
Dietert Co.
Eberbach & Son
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Fisher-Scientific Co.
General Biological
Goetze Niemer Co.
Howe Scale Co.
Humboldt Mfg. Co.
International Bus. Mach.
Jacobs Bros. Co.
Microchemical Service
Seedburo Equipment
Seederer-Kohlbusch, Inc.
Thompson Balance
Toledo Scale Co.
Troemner, Henry
Voland & Sons

SCALES, Larry Car
Buffalo Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Liquid
Exact Weight Scale Co.
Howe Scale Co.
Jacobs Bros. Co., Inc.
Merrick Scale Mfg.
Monsell, J. R.
Richardson Scale Co.
Toledo Scale Co

SCALES, Sacking (See Scales, Bag-Filling)

SCALES, Loss of Weight
Becker Div., Christian
Buffalo Scale Co.
Builders-Providence
Dietert Co.
Exact Weight Scale Co.
Jacobs Bros. Co.
Monsell, J. R.
Omega Machine
Proportioneers, Inc.
Seederer-Kohlbusch, Inc.
Streeter-Amet Co.
Thwing-Albert Inst.
Toledo Scale Co.

SCALES, Mud
Chatillon & Sons

SCALES, Over & Under
Automatic Scale
Becker Div., Christian
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Moisture Register Co.
Seedburo Equipment
Streeter-Amet. Co.
Toledo Scale Co.
Triner Sales Co.
Troemner, Henry

SCALES, Packaging
Automatic Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Monsell, J. R.
Richardson Scale Co.
Toledo Scale Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALES, Platform
Becker Div., Christian
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
Humboldt Mfg. Co.
International Bus. Mach.
Monsell, J. R.
Seedburo Equipment
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Portable
Black & Decker
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Dillon & Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Kron Co.
Richardson Scale Co.
Seedburo Equipment
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.
Voland & Sons

SCALES, Predetermined Weight
Automatic Scale
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse, & Co.
Gump Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Merrick Scale Mfg. Co.
Monsell, J. R.
Richardson Scale Co.
Schaffer Poidometer Co.
Seederer-Kohlbusch, Inc.
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Recording
Automatic Temp. Control
Buffalo Scale Co.
Fairbanks, Morse & Co.
Hagan Corp.
Howe Scale Co.
Merrick Scale Mfg. Co.
Minnesota Electronics
Monsell, J. R.
Richardson Scale Co.
Streeter-Amet Co.
Taller & Cooper
Toledo Scale Co.
Wallace & Tiernan

SCALES, Remote Indicating
Automatic Temp. Control
Conoflow Corp.
Dillon & Co.
Emery Co., A. H.
Exact Weight Scale Co.
Howe Scale Co.
Merrick Scale Mfg.
Monsell, J. R.
Republic Flow Meters
Streeter-Amet Co.
Taller & Cooper
Toledo Scale Co.

SCALES, Rolling Mill
Buffalo Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Selecting
Exact Weight Scale
Howe Scale Co.
Merrick Scale Mfg.
Toledo Scale Co.

SCALES, Solder Test
Central Scientific Co.
Exact Weight Scale
Seederer-Kohlbusch, Inc.
Troemner, Henry

SCALES, Steel
American Meas. Insts.
Dillon & Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Lufkin Rule Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Testing
Buffalo Scale Co.
Chatillon & Sons
Dillon & Co.
Eberbach & Sons
Exact Weight Scale
Gump Co.
Howe Scale Co.
Humboldt Mfg. Co.
Jacobs Bros. Co.
Newark Scale Works
Seedburo Equipment
Taller & Cooper
Toledo Scale Co.

SCALES, Textile
Becker Div., Christian
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Seederer-Kohlbusch, Inc.
Streeter-Amet Co.
Suter, Alfred
Toledo Scale Co.
Triner Sales Co.

SCALES, Track
Baldwin Locomotive
Buffalo Scale Co.
Emery Co., A. H.
Fairbanks, Morse & Co.
Howe Scale Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Truck
Black & Decker
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.,
Howe Scale Co.
Seedburo Equipment
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Water Meter
Alteneder & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Jacobs Bros. Co.
Toledo Scale Co.

SCALES, Yardage
Amthor Testing Inst.
Brown & Sharpe
Buffalo Scale Co.
Exact Weight Scale
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Toledo Scale Co.

SCREENS, Solar Projecting
Fecker, Inc.

SCREENS, X-Ray Fluoroscopic
Canadian Radium
Eastman Kodak Co.
General Elec. X-Ray Dept.
General Luminescent
Goetze-Niemer Co.
Kelley-Koett Mfg. Co.
North American Philips
Patterson Screen Div.
Picker X-Ray
Stoelting Co., C. H.
U. S. Radium Corp.
Westinghouse X-Ray Co.

SCREENS, X-RAY Intensifying (See Screens X-Ray Fluorescopic)

SEED SIEVE SETS
Ballauf Mfg. Co.
Seedburo Equipment

SEGER CONES (See Cones, Pyrometric)

SEISMOGRAPHS
Alpha Instrument Co.
American Inst. Co.
Brown Geophysical
Century Geophysical
Coleman Inst. & Mfg.
Consolidated Engg.
Engineering Labs., Inc.
Geophysical Instrument
Gilman Scientific
Hathaway Instrument
Henson Co., Fred C.
Heiland Research Corp.
Martin-Hubbard Corp.
Mico Instrument Co.
Southwestern Ind. Elec.
Sprengnether Instrument

SELF-OPERATING CONTROLLERS & REGULATORS, AUTOMATIC
American Inst. Co.
Area Regulators, Inc.
Atlas Valve Co.
Automatic Elec. Chicago
Bailey Meter Co.
Bastian-Blessing
Beck Co.
Betts & Betts
Bristol Co.
Brooke Engineering

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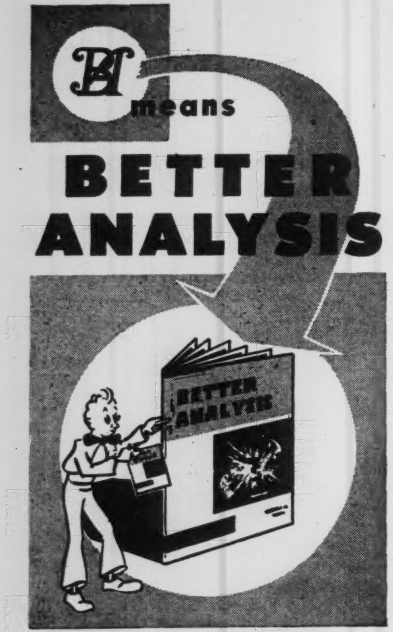

INSTRUMENTS
for
MEASUREMENT
and
CONTROL

1. **DIRECT READING SPECTROMETER** (Metals)
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5. **GAS ANALYZER** (Continuous Plant Analysis)

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Mason-Neilan Regulator
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Partlow Corp.
Perfex Corp.
Robinette Co.
Sarco Co., Inc.
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Scientific Inst. Co.
Seely Inst. Co.
Shallcross Controls
Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
Vapor Recovery Systems
Vectron, Inc.
Wheelco Instruments

SERVOMOTORS, Electric Motor

Arma Corporation
Automatic Temp. Control
Barber-Colman
Beck Co.
Collins Radio
Doelcam Corp.
Eclipse-Pioneer Div.
Electric Indicator
Electronic Associates
Fairchild Camera
Ford Instrument
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Hansen Mfg. Co.
L. A. B. Corp.
Lear, Inc.
Leeds & Northrup
Martin-Hubbard Corp.
Maxson Corp.
Minneapolis-Honeywell
Oster Mfg., John
Reeves Instrument
Robinette Co., W. C.
Schwien Engg.
Servo Corp. of America
Servomechanisms, Inc.
Shallcross Controls
Sperry Gyroscope Co.
Summers Gyroscope
Wilson & Co.

SERVOMOTORS, Electric Solenoid

Clark Cooper Co.
Instrument Dev. Labs.
Martin-Hubbard Corp.
Ruggles-Klingemann
Schwien Eng. Co.
Servo Corp. of Amer.
Shallcross Controls
Summers Gyroscope

SERVOMOTORS, Hydraulic

Askania Regulator Co.
Bailey Meter Co.
Cash Co.
Dennison Engineering
General Electric
General Regulator Corp.
Hagan Corp.
Martin-Hubbard Corp.
Mason-Neilan Regulator
Maxson Corp.
Republic Flow Meters
Servo Corp. of Amer.
Shallcross Controls

SERVOMOTORS, Mechanical

Airflo Instrument Co.
Foxboro Co.
Hagan Corp.
Lears, Inc.
Martin-Hubbard Corp.
Servo Corp. of America
Servomechanisms, Inc.
Summers Gyroscope

SERVOMOTORS, Pneumatic

Askania Regulator Co.
Bailey Meter Co.
Cash Co.
Emery Co., A. H.
Hagan Corp.
Mason-Neilan Regulator
Maxson Corp.
Minneapolis-Honeywell
Moore Products
Republic Flow Meters
Servo Corp. of Amer.

SEXTANTS

Alpha Instrument Co.
Bausch & Lomb Opt.
Bray Optical Co.
Dusenbery Co.
Eclipse-Pioneer Div.
Fairchild Camera
Keuffel & Esser Co.
Leupold & Stevens
Link Aviation Devices
Negus, T. S. & J. D.
Suverkop Instruments
Unertl Optical Co.
Warren-Knight Co.
White Co., Inc.

SHIP LOGS

Elec. Tachometer Corp.
Kenyon Instrument Co.
Negus, T. S. & J. D.
Pitometer Log Corp

SHOCK MOUNTINGS (See Mountings)

SHUNT METERS (See Meters, Shunt)

SHUNTS

Associated Research
Bradshaw
Burlington Inst Co.
Cole Instrument
Columbia Elec. Mfg.
De Jur-Amsco
Electronic Dev. Lab.
Esterline-Angus Co.
General Elec. Co.
Gray Instrument
Hickok Elec. Inst. Co.
Instrument Resistors, Inc.
International Resistance
Leeds & Northrup
Lewis Engineering
Madison Elec. Prod. Div.
Norton Electrical Inst.
Precision Resistor Co.
Radio City Products Co.
Rawson Electrical Inst.
Reiner Electronics
Roller-Smith Co.
Rubicon Co.
Sangamo Electric
Sensitive Research Inst.
Shallcross Mfg.
Standard Science Sup.
Simpson Electric Co.
Sun Manufacturing
Triplett Electrical Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Winslow Co.

SHUNTS, Standard

Associated Research
Cambridge Instrument Co.
Cole Instrument
De Jur-Amsco
Electronic Dev. Lab.
General Electric Co.
Gray Instrument Co.
Hickok Electrical Inst.
Instrument Resistors Co.
International Resistance
Leeds & Northrup Co.
Lewis Engineering
Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg.
Triplett Elec. Inst. Co.
Weston Elec. Inst. Corp.
Winslow Co.

SIEVE SHAKERS

American Inst. Co.
Braun Corp.
Central Scientific
Dietert Co.
Humboldt Mfg. Co.
Newark Wire Cloth
Precision Scientific
Williams Apparatus

SIEVES, TESTING

American Inst. Co.
Central Scientific Co.
Dietert Co.
Fisher Scientific Co.
Humboldt Mfg. Co.
Newark Wire Cloth
Precision Scientific Co.
Riehle Division
Scientific Inst. Co.
Weber Brothers Metal

SIGHT FEED BUBBLERS

Bailey Meter Co.
Brooks Rotameter
Fischer & Porter
Industrol Corp.
Meriam Instrument
Moore Products

SIGHT METERS

De Jur-Amsco
General Elec. Co.
G-M Labs.
Triplett Elec. Inst.
Weston Elec. Inst. Corp.

SIGHTS, GUN, Telescopic

Bausch & Lomb Opt.
Bell & Howell Co.
Clark & Sons
Fecker, Inc.
Kollmorgan Optical Co.
Leupold & Stevens
Palos Optical Co.
Perkin-Elmer Co.
Plummer & Kershaw
Unertl Optical Co.
Zeiss, Inc., Carl

SIGNAL GENERATORS (See Generators, Signal)

SIGNALING DEVICES Automatic

Auth Elec. Spec.
Autocall Co.
Automatic Elec. Chicago
Automatic Elec. Mfg.
Automatic Temp. Controls
Bailey Meter Co.
Beck & Co.
Betts & Betts
Browning Labs.
Bullard Co.
Cannon Electric
Cincinnati Time Rec.
Clark Cooper Co.
Dorothea Mechanisms, Gale
Eastern Industries
Elec. Indicator Corp.
Fischer & Porter
Foxboro Co.
General Elec. Co.
Guardian Elec. Mfg. Co.
Haydon Co., A. W.
Holtzer-Cabot Elec. Co.
Industrial Timer Corp.
International Bus. Mach.
Leslie Co.
Leupold & Stevens
Lumenite Co.
Magnetrol, Inc.
Martin-Hubbard Co.
Mine Safety App. Co.
National Time & Signal
Panellit, Inc.
Photoswitch, Inc.
Production Instrument
Rochester Mfg. Co.
Rosen Engg.
Spence Engineering Co.
Standard Elec. Time
Thompson Clock Co.
Viking Instruments
Wallace & Tiernan
Warren Telechron
Wheelco Instruments

SIGNALING DEVICES, Traffic

Am. Gas Accumulator
Automatic Elec. Sales
Automatic Temp. Control
Bullard Co.
Eagle Signal Corp.
Eastern Industries
Edison Electrical Controls
General Elec. Co.
Menlo Research Lab.
National Time & Signal
Photoswitch, Inc.
Sangamo Electric Co.

SILICA, VITREOUS

Crystal Research Labs.
Engelhard, Charles
General Electric
Thermal Syndicate, Ltd.

SINE BARS

DoAll Co.
Herkimer Tool
Jansson Gage Co.
Swedish Gage Co.
Thomas Tool
Vinco Corp.

SLIDE RULES (See Drawing Instruments)

SLIDING GAGES (See Gages, Sliding)

SLOW MOTION STUDY EQUIPMENT

Annis Co.
Bolsey Corp.
Boulin Instrument Corp.
Commercial Engg. Labs.
General Radio Co.
Telechron, Inc.

SLUMP CONES (See Cones, Slump)

SMOKE DENSITY, Indicators & Recorders

Ace Instrument Co.
Airdesign, Inc.
Associated Research
Bailey Meter Co.
Bristol Co.
Brooke Engineering
Cole Instrument
Denver Fire Clay Co.
De-Tec-Tronic Labs.
Dickson Co.
Edwards, L. V.
Electronic Lab.
Ess Instrument Co.
General Elec. Co.
General Power Plant
General Television Corp.
Leeds & Northrup Co.
Lumenite Elec.
McNeill Engineering
Photoswitch, Inc.
Photovolt Corp.
Preferred Utilities Mfg.
Refinery Supply
Rockwell Engr. Co.
Thwing-Albert Inst. Co.
Weston Elec. Inst. Corp.
Worner Electronics

SMOOTHNESS RECORDERS (See Surface Finish Analyzers)

SOLAR PROJECTING SCREENS (See Screen, Solar Projecting)

SOLDERING IRONS

Stafford Co.
Hexacon Electric

SOUND INDICATORS & ANALYZERS (See Indicators, Sound & Analyzers, Sound)

SOUND LEVEL METERS

Amplifier Co.
Assembly Products
Audio Development
Audio-Tone Oscillator
Ballantine Labs.
Burlington Inst. Co.
Clough-Brengle Co.
Cole Instrument
Dale Instruments
Daven Co.
De Jur-Amsco Corp.
Dittmore & Freimuth
Electro-Tech Equipment
Electronic Development
Electronic Instrument
Feiller Engineering
General Elec. Co.
General Radio Co.
Hickok Elec. Inst.
Kay Electric Co.
Marion Electrical Inst.
Massa Labs.
Meters, Inc.
Precision Apparatus Corp.
Radio City Products Co.
RCA Div.
Scott, Inc., Hermon
Shallcross Mfg. Co.
Sherron Metallic
Simpson Electric
Sound Apparatus Co.
Techno Inst.
Triplett Electric Inst.
Viking Instruments
Westinghouse Elec.
Weston Elec. Inst. Corp.

SOUNDING LEADS

Bliss & Co.
G. M. Mfg. Co.
Kenyon Instrument Co.
Moeller Instrument Co.
Negus, T. S. & J. D.

SOUNDING MACHINES

Bendix Marine Products
G. M. Mfg. Co.
Hand & Sons
Kenyon Instrument Co.
Moeller Instrument Co.
Negus, T. S. & J. D.

SOUNDING TUBES

Kimble Glass Co.
Leupold & Stevens
Moeller Instrument Co.
Negus, T. S. & J. D.

SPECIFIC GRAVITY Indicators & Recorders (See Gravity)

SPECTRAL TUBES CONTAINING RARE GASES (See Spectrum Tubes)

SPECTROGRAPHS

Applied Research Labs.
Baird Associates
Bausch & Lomb Optical
Biddle Co., James G.
Farrand Optical
Fecker, Inc.
Gaertner Scientific Corp.
Heinrich Co., Carl
Henson Co., Fred C.
Jarrell-Ash
Precise Measurements Co.
Spencer Lens Co.
Unertl Optical Co.
Zeiss, Inc., Carl

SPECTROGRAPHS, Mass

Berkeley Scientific
Furst Electronics
General Electric Co.
Process & Instruments
Phoenix Precision Insts.
Skaneateles Mfg. Co.

SPECTROGRAPHS, Oscillating

General Elec. Co.
Hayes Scientific App.
Unertl Optical Co.

SPECTROGRAPHS, Raman

Jarrell-Ash Co.
Lane-Wells Co.

SPECTROGRAPHS, Vacuum

Baird Associates
Biddle Co., James G.
Central Scientific Co.
Dietert Co.
Farrand Optical
Fecker, J. W.
Jarrell-Ash Co.
Skaneateles Mfg. Co.
Thomas Co., Arthur H.
Unertl Optical Co.

SPECTROGRAPHS, X-ray

Biddle Co., James G.
Central Scientific Co.
Gaertner Scientific
General Elec. X-Ray Dept.
Hayes Scientific App.
Henson Co., Fred C.
Jarrell-Ash Co.
Kelley-Koett Mfg.
North Amer. Philips
Unertl Optical Co.
Victoreen Instrument Co.
Wyland, G. C.

SPECTROMETERS

American Optical
Applied Research Labs.
Baird Associates
Bausch & Lomb Optical
Beckman Instruments
Consolidated Engg.
Dearborn Scientific
Farrand Optical Co.
Gaertner Scientific Corp.
Jarrell-Ash Co.
Martin-Hubbard Corp.
Perkin-Elmer Corp.
Precise Measurements
Rudolph & Sons
Unertl Optical Co.
Welch Scientific

SPECTROMETERS, Infra-Red

Baird Associates
Beckman Instruments
Farrand Optical
Gaertner Scientific Corp.
General Elec. Co.
Jarrel-Ash. Co.
Perkin-Elmer Corp.
Pfaltz & Bauer
Phoenix Prec. Inst.

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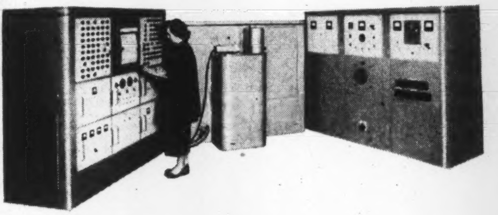

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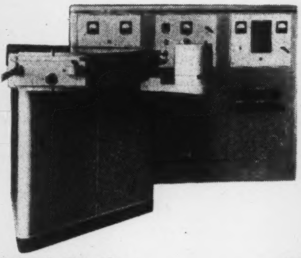

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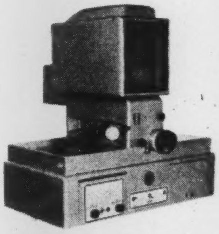

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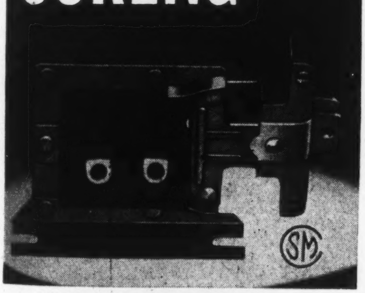

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Farrand Optical
General Elec. Co.
Jarrell-Ash Co.
Librascope
Phoenix Precision Inst.

SPECTROSCOPES
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Bausch & Lomb Opt.
Central Scientific Co.
Dearborn Scientific
Fecker, Inc.
Fish-Schurman Corp.
Gaertner Scientific Corp.
General Elect. X-Ray
Jarrell-Ash Co.
Laboratory Specialties
Leitz, Inc.
Precise Measurements Co.
Rudolph & Sons
Unertl Optical Co.
Welch Scientific

SPECTROSCOPE, Quartz
Gaertner Scientific Corp.
Precise Measurements Co.
Unertl Optical Co.

SPECTROSCOPES, Stellar
American Optical Co.
Central Scientific Co.
Eastern Scientific Co.
Fecker, Inc.
Mico Instrument Co.
Perkins-Elmer Corp.
Unertl Optical Co.
Zeiss, Inc., Carl

SPECTRUM TUBES
Central Scientific Co.
Gaertner Scientific Corp.
General Physical Lab.
Jarrell-Ash Co.
Skaneateles Mfg. Co.

SPEED, Indicators
Anithor Testing Inst. Co.
Associated Research
Automatic Elec. Chicago
(Continued)
Bailey Meter Co.
Biddle Co., Jas. G.
Boulin Instrument Corp.
Bristol Co.
Brown & Sharpe
Chicago Elec. Tachometer
Cincinnati Time Rec.
Cole Instrument
Commercial Research
Cramer & Co., Inc.
Electric-Speed Ind. Co.
Elec. Tachometer Corp.
Elgin National Watch
Engineering Res. Dev.
Esterline-Angus Co.
Foxboro Co
Gaertner Scientific Corp
General Elec. Co.
General Radio
Hasler-Tel. Co.
Hastings Inst. Co.
Hathaway Inst. Co.
Hickok Elec. Inst. Co.
Jaeger Watch Co.
Jones-Motrola
Kay Electric
Leeds & Northrup Co.
Manning, Maxwell & Moore
McDonnell Odometer Co.
Metron Instrument Co.
Minneapolis-Honeywell
Moisture Register Co.
Potter Instrument
Precision Therm.
Roller-Smith
Sangamo Electric Co.
Scherr Co., Inc.
Simpson Electric
Standard Elec. Time
Starrett Co.
Sticht Co.
Triplett Elec. Inst.
U. S. Taximeter
Veeder-Root, Inc.
Walkirt Co.
Westberg Mfg. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Zernickow Co., O.

SPEED, Recorders (See Speed Indicators)

SPEED, Regulators (See Controllers, Automatic, Tachometric)

SPEED SYNCHRONIZING INDICATORS
Cole Instrument
Electric Speed Ind. Co.
Electric Tachometer
General Elec. Co.
Potter Instrument
Westberg Mfg. Co.

SPEEDOMETERS
Boulin Insrument Corp.
Central Scientific
(Continued)
Commercial Research
Corbin Screw Corp.
Cramer & Co., Inc.
Electric Auto-lite
Elec. Tachometer Corp.
Electronic Associates
Engineering Res. & Dev.
General Elec. Co.
Jones-Motrola
Stewart-Warner Corp.
Westinghouse Elec.

SPHEROMETERS
Engis Equipment
Gaertner Scientific
Mann Co., W. I.

SPHYGMOMANOMETERS
Cambridge Inst. Co.
G. M. Mfg. Co.
Hellige, Inc.
Precision Thermometer
Stoelting Co., C. H.
Taylor Inst. Cos.

SQUARES, Combination & Machinists'
Brown & Sharpe
DoAll Co.
Jansson Gage Co.
Lufkin Rule Co.
Mico Instrument Co.
Millers Falls
Starrett Co.
Thomas Tool
Warren-Knight Co.

STANDARD CELLS (See Cells, Standard)

STANDARD, Acoustic
Massa Laboratories

STANDARD, Capacitance
Aeovox Corp.
Brown Electro-Measurement
Cambridge Inst. Co.
General Radio Co.
Industrial Instruments
Leeds & Northrup Co.
Rubicon Co.
Solar Mfg. Corp.
United Condenser

STANDARDS, Color
Fish-Schurmann Co.
Hellige, Inc.
Munsell Color Co.
Tagliabue Div.
Taylor & Co., W. A.

STANDARDS, E.m.f.
Cambridge Inst. Co.
Leeds & Northrup Co.
Gray Instrument
Rubicon Co.

STANDARDS, Frequency
American Inst. Co.
American Time Prods.
Berkeley Scientific
Browning Laboratories
Crystal Research Labs.
Espey Mfg.
Feiler Engineering
Ferris Inst. Cor.
General Electric Co.
General Radio Co.
Gertsch Products
Hewlett-Packard Co.
MacLeod & Hanopol
Millen Mfg. Co.
Polytechnic Research & Dev.
Potter Instrument
RCA Div.
Riverbank Laboratories
Sherron Metallic
Telechron. Inc.
Times Facsimile Corp.

STANDARDS, Gamma Roy (See Standards, radioactivity)

STANDARDS, Inductance
Cambridge Inst. Co.
General Radio Co.
Leeds & Northrup Co.
Rubicon Co.

STANDARDS, Length
Acme Industrial
Gaertner Scientific
Gurley, W. & L. E.
Sheffield Corp.
Size Control Co.
Swedish Gage Co.
Van Keuren Co.

STANDARDS, Mass
Gurley, W. & L. E.
Seedrer-Kohlbusch, Inc.

STANDARDS, Potential
Leeds & Northrup Co.
Rubicon Co.
Sensitive Research Inst.

STANDARDS, Pressure
Green, Henry J.
Precision Therm.

STANDARDS, Radioactivity
Clarkstan Corp.
Kelley-Koett Inst. Div.
Nucleonic Corp.
Tracerlab

STANDARDS, Resistance
Associated Research
Beck Bros.
Cambridge Inst. Co.
Cole Instrument
Cutler-Hammer, Inc.
Federal Instrument
General Radio Co.
Gray Instrument
Hardwick, Hindle, Inc.
Industrial Insts. Inc.
Instruments Resistors Co.
International Resistance
Leeds & Northrup Co.
Mepco
Resistance Products Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Sticht & Co.
Victoreen Instrument Co.
Ward Leonard Elec. Co.
General Radio Co.
Massa Labs.
RCA Div.
Shallcross Mfg. Co.

STANDARDS, Sound Level
Audio Tone Oscillator
Massa Laboratories

STANDARDS Temperature
Ever Ready Thermometer
Green, Henry J.
Leeds & Northrup Co.
Moeller Instrument Co.
Precision Therm.
Revere Co.
Tagliabue Div.

STANDARDS, Time
American Inst Co.
American Time Prods.
General Radio Co.
Potter Instrument
Standard Elec. Time Co.
Steelting Co., C. H.
Varo Mfg. Co.
Warren Telecron Co.

STANDARDS, Tuning Fork Frequency
American Time Products
Marconi Instruments Ltd.
Riverbank Labs.

STANDARDS, Volume
Gurley, W. & L. E.
Kontes Glass Co.

STATION CONTROL EQUIPMENT
American Meter Co.
Arca Regulators Inc.
Control Corp.
Elec. Indicator Corp.
General Elec. Co.
RCA Manufacturing
Sherron Metallic

STEAM METERS (See Flow Meters, Steam)

STEEL TAPES (See Tapes Steel)

STELLAR SPECTROSCOPES (See Spectroscopes, Stellar)

STEREOSCOPES
Abrams Instrument
Fairchild Camera
General Biological
Stratex Instrument Co.

STEREOSCOPES, X-RAY
Abrams Instrument
Bausch & Lomb Optical
Fairchild Camera
General Elec. X-Ray Dept.
Kelley-Koett Mfg. Co.
North American Philips
Picker X-Ray
Westinghouse X-Ray Co.

STETHOSCOPES, ENGINEERS
Brush Development Co.
Engineers Res. & Dev.
Fairchild Camera
Gilmore, E. R.

STIFFNESS TESTERS, PAPER (See Tester, Stiffness, Paper)

STILLS, AUTOMATIC WATER
Barnstead Still & Steril
Central Scientific Co.
Electric Hotpack Co.
Fish-Schurman Co.
Goetze Niemer
Precision Scientific
Specialty Glass Co.
Stokes Machine Co.
Weber Bros. Metal Works

STIRRERS, LABORATORY, Variable Speed
Aloe Co., A. S.
Western Electric
Central Scientific Co.
Eastern Engg. Co.
Eberbach & Son
Fish-Schurman Corp.
Fisher-Scientific
Humboldt Mfg. Co.
Omega Machine
Palo-Myres, Inc.
Phipps & Bird
Precision Scientific
Technical Products

STOP WATCHES (See Watches, Stop)

STRAIGHT EDGES
Acme Industrial
American Meas. Inst.
Brown & Sharpe
Dietzen Co.
Keuffel & Esser Co.
Negus, T. S. & J. D.
Scherr Co., George
Speidel & Co.
Swedish Gage Co.
Warren-Knight Co.
Weber Co., F.
White Co., David

STRAIGHTENING VANES
Bailey Meter Co.
Builders Providence
Penn Ind. Inst. Corp.
Robinson Orifice Fitting
Simplex Valve & Meter
Taylor Instrument Cos.

STRAIN GAGES (See Gages, Strain)

STRAIN TESTERS, GLASS (See Testers, Strain (Glass)

STRAIN-TIME RECORDERS
Bailey Meter Co.
Baldwin Locomotive
Brush Development
Cambridge Inst, Co.
Consolidated Engineering
Foxboro Co.
Hathaway Instrument
Heiland Research
Keuffel & Esser Co.

STREAM GAGING INSTRUMENTS
Foxboro Co.
Gurley, W. & L. E.
Hathaway Instrument
Keuffel & Esser Co.
Leupold & Stevens
Martin-Hubbard Corp.

STRESS INDICATORS
Ames Co., B. C.
Bailey Meter Co.
Baldwin Locomotive
Cambridge Inst. Co.
Consolidated Engg.
Dillon & Co.
Emery Co., A. H.
Federal Products Corp.
General Electric Co.
Hathaway Instrument
Magnaflux Corp.
Metron Instrument
Minnesota Electronics
Riehle Div.
Statham Labs.

STRESS-STRAIN, Indicators
Ames Co., B. C.
Anderson, Arthur R.
Bailey Meter Co.
Baldwin Locomotive
Brush Development
Chatillon & Sons
Consolidated Engg.
Electronic Products
Emery Co., A. H.
Hathaway Instrument
Magnaflux Corp.
Metron Instruments
Minnesota Electronics
Nosker Eng. Prod.
Sheffield Corp.
Statham Labs.
Swedish Gage Co.
Taller & Cooper
Trimount Inst. Co.

STRESS-STRAIN, Recorders
Bailey Meter Co.
Baldwin Locomotive
Brush Development
Cambridge Inst. Co.
Century Geophysical
Consolidated Engg.
Electro Products Labs.
Electronic Products
Emery Co., A. H.
Flader, Inc., Fredric
Hathaway Instrument
Heiland Research
Metron Instruments
Minnesota Electronics
Nosker Eng. Prod.
Olsen Testing Machine
Riechle Div.
Sheffield Corp.
Statham Labs.
Taller & Cooper
Trimount Inst. Co.

STOBOSCOPES
Associated Research
Berkshire Laboratories
Biddle Co., Jos. G.
Boulin Inst. Corp.
Commercial Research
Communication Meas. Lab.
Conn, Ltd., C. G.
Electric Eye Equip.
Electronic Engineers
Engineering Res. & Dev.
General Radio Co.
Huggins Labs.
Ideal Laboratory Tool
Sylvania Elec. Prod.
Welch Scientific
Westinghouse Elec.
Zeiss, Inc., Carl

SULPHUR BOMBS (See Rombs, Sulphur)

SULPHUR DIOXIDE, Indicators (See Gas Analyzers, Sulphur Dioxide) Recorders (See Gas Analyzers, Sulphur Dioxide)

SUN COMPASS
Abrams Instrument
Brunson Instrument
Dusenbury Co.
Geophysical Inst. Co.

SUNSHINE, Indicators & Recorders
Cambridge Inst. Co.
Friez Instrument
General Elect. Co.
G. M. Mfg. Co., Inc.
Instruments Corp.
Leeds & Northrup Co.
Taylor Inst. Co.
White Co., Inc.

SUPERVISORY CONTROL EQUIPMENT
Autocall Co.
Automatic Elec. Chicago
Bristol Co.
(Continued)
Builders Providence
Control Corp.
Cramer & Co., Inc.
General Elec. Co.
Guardian Elec. Mfg. Co.
Leeds & Northrup Co.
Minneapolis-Honeywell
Tagliabue Div.
Westinghouse Elec.

SURFACE FINISH COMPARATORS (See Comparators, Surface Finish)

SURFACE FINISH SPECIMENS
Acme Industrial
Baird Associates
Blake Co., Edward
Brush Development
General Elec. Co.
Link Eng. & Mfg.
Pipe Machinery
Surface Checking Gage.

SURFACE FINISH STANDARDS
Brush Development
Compar Inst. Co.
Pipe Machinery Co.
Surface Checking Gage

SURFACE FINISH TESTERS
Baird Associates
Blake Co., Edward
Brush Development Co.
Buehler, Adolph I.
Compar Inst. Co.
Comtor Co.
Federal Products Corp.
General Elec. Co.
Link Eng. & Mfg.
Physicists Research
Sheffield Corp.
Surface Checking Gage
Swedish Gage
Taber Inst. Corp.
Wilder, R. S.
Williams Apparatus

SURFACE GAGES (See Gages, Surface

SURFACE PLATES GLASS
Bausch & Lomb Optical
Binswanger & Co.
Clark & Sons
DoAll Co.
Fecker, J. W.
Fish-Schurman Co.
Geophysical Inst. Co.
Palos Optical Co.
Zeiss, Inc., Carl

SURFACE PLATES STONE Crest)
Herman Stone Co.

SURGE CREST AMMETERS (Ammeters, Surge-

SURGE, Indicators & Recordings
Cook Electric
Elec. Indicator Corp.
General Electric Co.
Hathaway Instrument
Landis & Gyr.
Sheffield Corp.
Taylor Inst. Cos.

SURVEY FOOT-ODOMETERS (See Odometers)

SURVEYING INSTRUMENTS
Abrams Instrument
Alpha Instrument Co.
Beckman Co., L.
Berger & Sons
Bliss & Co.
Bray Optical Co.
Bruning Co., Inc.
Brunson Instrument
Dietzgen Co.
Engis Equipment
Ferner Co.
Geier & Bluhm
Goldak Co.
Gurley, W. & L. E.
Hastings Inst. Co.
Kenyon Instrument Co.
Keuffel & Esser Co.
Leupold & Stevens
Lufkin Rule Co.
Pittsburgh Ins. & Mach.
Post Co., Frederic
Republic Lens Co.
Shepard Labs.
Speedometer Electric Co.
Speidel & Co.
Sprengnether Inst.
Starrett Co.
Stratex Instrument Co.
Suverkrop Instruments
Ulmer Co., J. C.
United States Blue Print
Warren Knight Co.
Weber Co.
White Co., Inc.
Zeiss, Inc., Carl.

SURVEYING INSTRUMENTS, Aneroid
Am. Paulin System
Dietzen Co.
Heinrich Co., Carl
Wallace & Tiernan
Warren-Knight Co.
White Co.

SURVEYING INSTRUMENTS, Underground, for wells or bore holes
Eastman Oil Well
Engineering Labs., Inc.
Engis Equipment
Geophysical Inst. Co.
Halliburton Oil Well
Heiland Research
Sperry-Sun Well Survey
Warren-Knight Co.
White Co.

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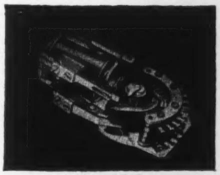

type 44

type 45

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BARKSDALE
sole distributor of
MELETRON
PRESSURE ACTUATED SWITCHES

for industrial applications, offers a new pressure switch handbook to industrial users. This new issue was compiled for greater convenience in selecting pressure sensing instruments: it includes a selection table based on functional requirements, and a glossary of terms to aid in specifying equipment.

The book covers the entire industrial pressure switch field: Meletron diaphragm type vacuum and low pressure switches, Meletron Bourdon tube high pressure switches, Barksdale piston type long life switches, and various special function units. Send for your copy.

BARKSDALE
1566 EAST SLAUSON AVENUE, LOS ANGELES 11, CALIFORNIA

SURVEYOR'S CHAINS (See Surveyor's Instruments)

SURVEYORS FOOT METERS
Speedometer Electric Co.

SWITCHES, Air-operated
Automatic Temp. Control
Clark Cooper Co.
Cole Instrument
Cook Electric
Cutler-Hammer, Inc.
General Elec. Co.
Johnson Service Co.
Meletron Corp.
Mu-Switch Corp.
Rotron Div.
Shallcross Mfg. Co.
Tagliabue Div.
Westinghouse Elec.

SWITCHES, Automatic Transfer
Acro Switch Div.
Allen-Bradley Co.
Allied Control Co.
Anderson, A. & J. M.
Arrow-Hart & Hegeman
Autocall Co.
Automatic Control Co.
Automatic Electric Chicago
Automatic Switch Co.
Automatic Temp. Control
Barber-Colman
Cook Electric
Cramer & Co., Inc.
Cutler-Hammer, Inc.
Federal Telephone Co.
General Elec. Co.
Hart Mfg. Co.
Haydon Co., A. W.
H-B Instrument
Lumenite Electronic
Ward Leonard Elec. Co.
Westinghouse Elec.

SWITCHES, Counter-actuating
Electro-Tech Equipment
Hetherington, Inc.
Jo-Bell Products
Micro Switch
Photoswitch Inc.

SWITCHES, Instrument
Acro Switch Div.
Allen-Bradley Co.
Allis-Chalmers
Arrow-Hart & Hegeman
Autocall Co.
Automatic Electric Chicago
Automatic Temp. Control
Barber-Colman
Betts & Betts
Brown Electro-Measurement
Carter Parts Co.

(Continued)

Centralab Div.
Cinema Engr.
Cole Instrument
Cook Electric
Cutler-Hammer, Inc.
Daven Co.
Dittmore & Freimuth
Federal Anti-Capacity
General Cement Mfg.
General Elec. Co.
General Radio Co.
Hart Mfg. Co.
Industrial Insts., Inc.
J-B-L Inst. Co.
J-B-T Instruments
Kellogg Switchboard
Lewis Engg.
Mallory & Co.
McDonnell & Miller
Mercoid Corp.
Micro Switch Div.
Mossman, Inc.
Oak Mfg. Co.
Ohmite Mfg. Co.
Roller-Smith
Rubicon Co.
Sensitive Research Co.
Shallcross Mfg.
Teleoptic Co.
Thwing-Albert Instrument
Trimount Inst. Co.
Triplett Elec. Inst. Co.
United States Inst. Corp.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Wheelco Instrument
Winston Co.

SWITCHES, Magnetic
Allen Bradley Co.
Allis-Chalmers
Arrow-Hart & Hegeman
Autocall Co.
Automatic Switch Co.
Automatic Temp. Control
Clark Cooper Co.
Cook Electric
Cutler-Hammer, Inc.
General Cement Mfg.
General Elec. Co.
Jo-Bell Products
Neomatic Inc.
Soreng Mfg. Co.
Ward Leonard Elec. Co.

SWITCHES, Mercury
Arrow-Hart & Hegeman
Climax Div.
Continental Elec. Co.
Cutler Hammer, Inc.
Durakool, Inc.
Electronic Apparatus
Electro-Tech Equipment
Fredericks, George
General Cement Mfg.
General Elec. Co.
H-B Instrument

(Continued)

Kahl Scientific Inst.
Magnetrol Inc.
McAlear Mfg. Div.
Mercoid Corp.
Minneapolis-Honeywell
Rhodes, Inc.

SWITCHES, Pyrometer
Acro Switch Div.
Arrow-Hart & Hegeman
Bristol Co.
Brown Inst. Div.
Cole Instrument
Daven Co.
Engelhard, Chas.
Foxboro Co.
General Cement Mfg.
General Elec. Co.
J-B-L Instrument
Leeds & Northrup Co.
Lewis Engg Co.
Revere Corp.
Rowe Engineering
Tagliabue Div.
Thwing-Albert Inst. Co.
Triplett Elec. Inst.
United States Inst. Corp.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Wheelco Instruments
Winslow Co.

SWITCHES, Relay
Acro Switch Div.
Allen-Bradley Co.
American Relay & Controls
Arrow-Hart & Hegeman
Autocall Co.
Automatic Elec. Chicago
Automatic Switch Co.
Automatic Temp. Control
Betts & Betts
Clark & Co.
Cook Electric Co.
Cutler-Hammer, Inc.
Federal Telephone
Friez Instruments Div.
General Cement Mfg.
General Controls Co.
General Elec. Co.
Guardian Elec. Mfg. Co.
Hart Mfg Co.
H-B Instrument
Kellogg Switchboard
Mallory & Co.
Micro Switch Div.
Neomatic Inc.
Perfex Corp.
Photoswitch, Inc.
Roller-Smith
Skaneateles Mfg. Co.
Struthers-Dunn
Ward Leonard Elec. Co.
Warrick Co.
Westinghouse Elec.

SWITCHES, Rotary
Allen-Bradley Co.
Applied Science Corp.
Arrow-Hart & Hegeman
Autocall Co.
Automatic Elec. Chicago
Barber-Coleman
Bird Electronic
Brown Electro-Measurement
Carter Parts Co.
Centralab Div.
Clarostat Mfg. Co.
Cole Instrument
Cutler-Hammer, Inc.
Daven Co.
Dittmore & Freimuth
Eastern Specialty
Federal Telephone
Foxboro Company
General Cement Mfg.
General Control Co.
General Elec Co.
General Radio Co.
Guardian Elec. Mfg. Co.
H-B Instrument
Hetherington & Son
J-B-L- Instrument
J-B-T- Instruments
Leeds & Northrup Co.
Lewis Engg. Co.
Mallory & Co.
Micro Switch Div.
Neomatic Inc.
Oak Mfg. Co.
Ohmite Mfg. Co.
Roller-Smith
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Tagliabue Div.
Thwing-Albert Inst. Co.
Triplett Electrical Inst.
United States Inst. Corp.
Utah Radio Prods.
Westinghouse Elec.
Weston Elec. Inst. Corp.

SWITCHES, Selector
Acro Switch Div.
Allen-Bradley Co.
Allis-Chalmers
Arrow-Hart & Hegeman
Automatic Elec. Chicago
Betts & Betts
Bird Electronic
Carter Radio Co.
Centralab Div.
Cinema Engr.
Cole Instrument
Cook Electric
Cutler-Hammer. Inc.
Daven Co.
Federal Telephone
General Cement Mfg.
General Elec. Co.
Guardian Electric

(Continued)

H-B Instrument Co.
J-B-L- Instrument
Leeds & Northrup Co.
Lewis Engineering
Mallory & Co.
Meter Devices Co.
Mossman, Inc.
Oak Mfg. Co.
Ohmite Mfg. Co.
Revere Co.
Shallcross Mfg. Co.
Soreng Mfg. Co.
Thwing-Albert Inst. Co.
United States Inst. Corp.
Vectron, Inc.
Ward Leonard
Westinghouse Elec.
Wheelco Instrument

SWITCHES, Snap
Acro Switch Co.
Arrow-Hart & Hegeman
Automatic Temp. Control
Betts & Betts
Cherry-Channer Corp.
Clark Cooper Co.
Cutler-Hammer, Inc.
General Cement Mfg.
General Controls
General Elec. Co.
Guardian Electric
Hetherington & Son
J-B-L Instrument
Jo-Bell Products
Leeds & Northrup
Mallory & Co.
McAlear Mfg. Div.
Micro Switch Div.
Minneapolis-Honeywell
Mu-Switch Corp.
Perfex Corp.
Soreng Mfg. Co.
Ulanet Co., Geo.
Unimax Switch Corp.
Ward Leonard Elec. Co.
Westinghouse

SWITCHES, Thermostatic
Acro Switch Div.
Airite Prod. Co.
Advance Electric Co.
Allen-Bradley Co.
Barber-Colman
Betts & Betts
Bridgeport Thermo Co.
Burling Instrument Co.
Clark Cooper Co.
Control Products, Inc.
Cook Electric Co.
Dickson Co.
Fenwal, Inc.
Friez Instruments
General Cement Mfg.
General Controls
General Elec. Co.
Gleason-Avery, Inc.
Guardian Electric

(Continued)

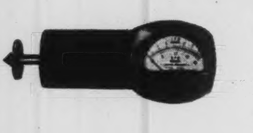
G-V Controls
Hart Mfg. Co.
Hawk Tool Eng. Co.
Mercoid Corp.
Micro Switch Div.
Minneapolis-Honeywell
Mu-Switch Corp.
Perfex Corp.
Powers Regulator
Shallcross Mfg. Co.
Smith Control & Insts.
Spencer-Thermostat Co.
Struthers-Dunn
Tagliabue Div.
Thwing-Albert Inst.
Ulanet Co., George
Unimax Switch Corp.
United Electronic Controls
Viking Instruments
Ward Leonard Electric Co.

SWITCHES, Time
Acro Switch Div.
Alina Corp.
Allen-Bradley Co.
Anderson, A. & J. M.
Autocall Co.
Automatic Elec. Mfg.
Automatic Temp. Control
Barber-Colman
Betts & Betts
Cincinnati Time Rec.
Cramer Co., Inc.
Cutler-Hammer, Inc.
Dimo-Gray Co.
Dorothea Mechanisms, Gale
Eagle Signal Corp.
Edison Instrument Div.
Electro-Tech. Equip.
Electyme Motor Prods.
General Cement Mfg.
General Controls
General Elec. Co.
Guardian Elec. Mfg. Co.
G-V Controls
Haydon Co., A. W.
Haydon Mfg. Co.
Industrial Timer
International Register Co.
Landis & Gyr, Inc.
Leich Elec. Co.
Lumenite Electronic
Lux Clock Mfg. Co.
Mallory & Co.
Mercoid Corp.
Minneapolis-Honeywell
Montgomery Mfg. Co.
Neomatic Inc.
Paragon Electric Co.
Perfex Corp.
Photoswitch, Inc.
Photovolt Corp.
Precision Products, Inc.
Richardson-Allen
Rhodes, Inc., M. H.

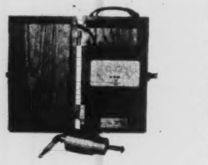
(Continued)

ELECTRIC
TACHOMETERS
Simplified RUGGED Design

HAND MODEL
Small size and light weight—ideal for any shop and production test application. Precision made, sealed ball bearings, and the elimination of wearing parts assure constant accuracy. Models from 0 –2,400 RPM + 800 FPM, 5,000, 15,000 and 25,000 RPM.



PORTABLE MODEL
Measures any rotating speed with sustained accuracy for production and laboratory use. Three-range expanded scale: 0 to 1000, 1000 to 2500, 2500 to 5000 and other models up to 20000 RPM. Stability assured with no contacts, brushes or batteries to wear out. Accuracy ½, 1, or 2% of full scale.



MOUNTED MODEL
Indicating Non-directional, forward or reverse speeds in any required range up to 25000 RPM. Available with SAE fittings and base mount. Calibrated to your exact needs. Completely enclosed and protected against moisture and dirt.

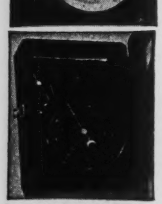
Special models made for any specific requirements.

THE ELECTRO-MECHANO CO.
261 Erie St., Milwaukee, Wis.

TACHOMETERS

TYPE "U"
UNIVERSAL
CENTRIFUGAL TYPE
5 Ranges in 1 Instrument
Cat. No. 303 30-12,000 RPM
Cat. No. 314 45-18,000 RPM
Cat. No. 322 60-24,000 RPM
Cat. No. 346 120-48,000 RPM
Bulletin 750-N

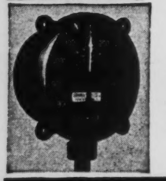
MODEL "J"
TRIPLE RANGE
CENTRIFUGAL
Cat. No. 312 300-12,000 RPM
Cat. No. 1412 100-12,000 RPM
SINGLE RANGES
100-1200 RPM, 200-2400 RPM
300-3600 RPM, 400-4800 RPM
Bulletins 760-N, 790-N



"JAQUET"
SPEED INDICATORS
(CHRONOMETRIC)
Guaranteed Accuracy within ½ of 1%
Cat. No. 2301 0-10,000 RPM
Cat. No. 2302 0- 1,000 RPM
Suitable double rated speed. 3 models, various accessories.
Bulletin 735-N

STATIONARY TYPE
MODEL "J"
Sizes, 3", 4", 5½", 8", 10", and 20" dial diameter, flexible shaft driven.
Many standard ranges reading RPM, FPM, YPM, etc.
Bulletins 795-N, 796-N 797-N

HERMAN H. STICHT CO., INC.
27 PARK PLACE NEW YORK, N.Y.



Sampsel Time Control
Sangamo Electric Co.
States Co.
Stoelting Co., C. H.
Stromberg Time Corp.
Telechron, Inc.
Thomas Clock Co., Seth
Thompson Clock Co.
Tork Clock
Ulanet Co., Geo.
Walker-Jamieson, Inc.
Walser Automatic Timer
Ward Leonard Elec. Co.
Westinghouse Elec.
Yellow Springs Inst.

SYNCHRONIZATION FORKS, Electrical (See Forks, Synchronization)

SYNCHRONOUS MOTORS (See Motors, Synchronous)

SYNCHROSCOPES
Control Corp.
Eclipse Aviation
Electric Controller
Feiler Engineering
General Elec. Co.
Hickok Elec. Inst. Co.
Kollsman Inst. Co.
Millen Mfg. Co.
Roller-Smith Co.
Triplett Elec. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.

TACHOGRAPHS
Amthor Testing Inst.
Biddle Co., Jas. G.
Cole Instrument
Cramer & Co., Inc.
Metron Instrument
Sticht Co.
Zeiss, Inc., Carl
Zernickow Co., O.

TACHOMETER TESTERS (See Testers, Tachometer)

TACHOMETERS, Centrifugal
Aeromarine Inst. Co.
Amthor Testing Inst. Co.
Associated Research
Barbour Stockwell Co.
Biddle Co., Jas. G.
Boulin Instrument Corp.
Corbin Screw Corp.
Durant Mfg. Co.
Eclipse-Pioneer Div.
Elec. Tachometer Corp.
Foxboro Co.
General Elec. Co.
Hays Corp.
Jones Motrola Sales
Kollsman Instrument
Manning, Maxwell & Moore

(Continued)

Pioneer Instrument Co.
Scherr Co., Inc.
Seedburo Equipment
Stewart-Warner Corp.
Sticht Co.
Veeder-Root, Inc.
Viking Instrument Co.
Zernickow Co., O.

TACHOMETERS, Chronometric
Amthor Testing Inst.
Associated Research
Berkeley Scientific
Biddle Co., Jas. G.
Boulin Inst. Corp.
Cramer & Co., Inc.
Elec. Tachometer Corp.
Elgin Nat'l. Watch Co.
Hasler-Tel Co.
Jaeger Watch Co.
Milwaukee Prec. Instr.
Pierce Watch Co.
Potter Instrument
Scherr Co., Inc.
Standard Elec. Time
Sticht Co.
Zernickow Co., O.

TACHOMETERS, Cross-pendulum
Amthor Testing Inst.
Associated Research
Biddle Co., Jas. G.
Manning, Maxwell & Moore
Sticht Co.
Zernickow Co., O.

TACHOMETERS, Electric
Bailey Meter Co.
Bristol Co.
Brown Inst. Div.
Chicago Elec. Tachometer
Clarke Inst. Corp.
Cole Instrument
Crown Ind. Prods.
Eclipse-Pioneer Div.
Electric Speed Ind. Co.
Elec. Tachometer Corp.
Electro Mechano Co.
Engineering Research & Dev.
Esterline-Angus Co.
Foxboro Co.
General Elec. Co.
Hastings Inst. Co.
Hathaway Inst. Co.
Hays Corp.
Hickok Elec. Inst. Co.
Ideal Industries, Inc.
Instrument Lab. Inc.
Jaeger Watch Co.
J-B-T Instruments
Jones Motorola Sales
Kay Electric
Kollsman Instrument
Martin Decker Corp.
Metron Instruments
Minnesota Electronics
Moisture Register Co.
Nat'l. Instrument Co.
Photocon Research
Pitometer Log Corp.
Potter Instrument
Scherr Co. Inc.
Standard Elec. Time
Sticht Co.
Sun Electric Corp.
Westberg Mfg. Co.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Winslow Co.
Yellow Springs Inst. Co.

TACHOMETERS, Electro-magnetic
Eclipse-Pioneer Div.
Electric Auto-Lite
Electric Tachometers
Electro Mechano Co.
General Electric Co.
Ideal Industries
Jaeger Watch Co.
Kollsman Inst. Co.
Nat'l. Instrument Co.
Potter Instrument
Standard Elec. Time Co.
Sun Electric
Stewart-Warner Corp
Triplett Elec. Inst.
Waltham Watch
Westberg Mfg. Co.
Westinghouse Elec.

TACHOMETERS, Fly-ball
Aeromarine Inst. Co.
Barbour Stockell Co.
Biddle Co., Jas. G.
Boulin Instrument Corp.
Elec. Tachometer Corp.
Jones Motrola Corp.
Manning, Maxwell & Moore
Sticht Co.
Viking Instrument Co.

TACHOMETERS, Ignition Actuated
Electro-Tech Equipment
Engineering Res. & Dev.
Potter Instrument
Stewart-Warner

TACHOMETERS, Portable
Amthor Testing Inst. Co.
Associated Research
Barbour Stockwell Co.
Biddle Co., Jas. G.
Boulin Instrument Corp.
Chicago Elec. Tachometer
Corbin Screw Corp.
Electro Mechano Co.
Elec. Tachometer Corp.
Foxboro Co.
General Elec. Co.
Hasler-Tel Co.
Ideal Industries
Jones Motrola Corp.
Manning, Maxwell & Moore
Rieker Instrument Co.
Scherr Co., Inc.
Stewart-Warner
Sticht Co.

(Continued)

Sun Electric Corp.
Viking Instrument Co.
Westberg Mfg. Co.
Winslow Co.
Zernikow Co.

TACHOMETERS, Recording
Bailey Meter
Bristol Co.
Engineering Res. & Dev.
Esterline-Angus
Potter Instrument

TACHOMETERS, Speed Limit Control
Askania Regulator Co.
Barbour Stockwell Co.
Bristol Co.
Flight Research Eng.
General Elec. Co.
Jones Motrola Corp.
Metron Instrument
Sticht Co.
Standard Elec. Time
U. S. Taximeter
Westberg Mfg. Co.
Zernikow Co.

TACHOMETERS, Stroboscopic
Associated Research
Berkshire Laboratories
Boulin Instrument Corp.
Clarke Inst. Corp.
General Radio Co.
Ideal Laboratory Tool
L. A. B. Corp.

TACHOMETERS, Tilting-ring
Amthor Testing Inst. Co.
Westberg Mfg. Co.
Zernikow Co.

TACHOMETERS, Vibrating Reed
Biddle Co., Jas. G.
J-B-T Instruments

TACHOSCOPES
Amthor Testing Inst. Co.
Biddle Co., Jas. G.
Scherr Co., Inc.
Sticht Co.
Zernickow Co., O.

TAFFRAIL LOGS; SHIP
Bliss & Co.
Hand & Sons
Westberg Mfg. Co.

TANGENT METERS (See Meters, Tangent)

TAPES, Oil Gauger's
Dietzgen Co.
Keuffel & Esser Co.
Lufkin Rule
Starrett Co.
White Co., David

TAPES, Steel
Bruning Co., Inc.
Dietzgen Co.
Kueffel & Esser Co.
Lufkin Rule Co.
Speidel & Co.
Starrett Co.
United States Blue Print
Warren-Knight Co.
Weber Co.
White Co., David

TAPES, Surveyor's (See Surveying Instruments)

TAPES, Woven
Lufkin Rule Co.
White Co., David

TAXI METERS
U. S. Taximeter

TELEMETERING SYSTEMS (See Remote Metering)

TELEMETERS (Surveying & Military—Optical)
Applied Science Corp.
Kollmorgen Optical Co.
Keuffel & Esser Co.
Pacific Div.
Pierce Watch Co.

TELESCOPES, Alignment
Acme Industrial
Bray Optical Co.
Dome Precision
Engis Equipment
Fecker, Inc.
Gaertner Scientific
General Engg. & Model
Howland Optical Co.
Keuffel & Esser Co.
Kollmorgen Optical Co.
Optical Ser. & Dev.
Palos Optical Co.
Perkin-Elmer Corp.
Plummer & Kershaw
Scherr Co., Inc.
Stratex Instrument Co.
Tinsley Laboratories
Unertl Optical Co.
White Co., Inc.

TELESCOPES, Astronimical
Bausch & Lomb Opt.
Buchele, W.
Clark & Sons
Davidson Mfg. Co.
Dome Precision
Eastern Science Co.
Fecker, Inc.
Gaertner Scientific Corp.
Henson Co., Fred C.
Ice Optical Co., H. C.
Mann Co., W. I.
Mico Instrument Co.
Palos Optical Co.
Perkin-Elmer Corp.
Plummer & Kershaw
Tinsley Labs.
Unertl Optical Co.
White Co.
Zeiss, Inc., Carl

TELESCOPES, Azimuth
American Optical
Clark & Sons
Fecker, Inc.
Gaertner Scientific Corp.
Kollmorgen Optical Co.
Palos Optical Co.
Perkin-Elmer Corp.
Plummer & Kershaw
Tinsley Labs.
Unertl Optical Co.
Warren-Knight Co.
Warner & Swasey Co.
White Co.
Zeiss, Inc., Carl

TELESCOPES, Bore & Internal Surface, Inspection
American Cystoscope
American Optical
Ames Co., B. C.
Fecker, J. W.
Gaertner Scientific
Kollmorgen Optical Co.
Leitz, Inc.
Lenox Inst. Co.
Magnaflux Corp.
Perkin-Elmer Corp.
Plummer & Kershaw
Scherr Co., Inc.
Schneider-Cogswell
Swedish Gage Co.
Unertl Optical Co.
Zeiss, Inc., Carl

TELESCOPES, Laboratory
American Optical
Bausch & Lomb
Central Scientific
Eberbach & Son
Fecker, Inc.
Gaertner Scientific Corp.
Henson Co., Fred C.
Optical Ser. & Dev.
Palos Optical Co.
Plummer & Kershaw
Precise Measurements Corp.
Ruska & Co.
Tinsley Laboratories
Unertl Optical Co.

TELESCOPES, Reflecting
Buchele, W.
Clark Sons
Fecker, Inc.
Fish-Schurman Co.
Gaertner Scientific
Henson Co., Fred C.
Howland Optical Co.
Ice Optical Co., H. C.
Palos Optical Co.
Perkin-Elmer Corp.
Plummer & Kershaw
Tinsley Labs.
Unertl Optical Co.
Warner & Swasey Co.
Zeiss, Inc., Carl

TELESCOPES, Refracting
Buchele, W.
Bausch & Lomb Opt.
Clark & Sons
Davidson Mfg. Co.
Fish-Schurman Co.
Fecker, Inc.
Gaertner Scientific
Henson Co., Fred C.
Howland Optical Co.
Ice Optical Co., H. C.
Keuffel & Esser Co.
Palos Optical Co.
Perkin-Elmer Corp.
Plummer & Kershaw
Tinsley Labs.
Unertl Optical Co.
Warner & Swasey Co.
Wollensak Optical Co.
Zeiss, Inc., Carl

TELESCOPES, Zenith
Clark & Sons
Fecker, Inc.
Gaertner Scientific Corp.
Ice Optical Co., H. C.
Perkin-Elmer Corp.
Plummer & Kershaw
Tinsley Labs.
Unertl Optical Co.
White Co., David
Zeiss, Inc., Carl

TELEVISION, Industrial
Diamond Power Specialty
Dumont
General Electric
RCA

TENSIOMETERS
Baldwin Locomotive
Boulin Instrument Corp.
Central Scientific Co.
Chatillon & Sons
Dillon Co.
Federal Products Corp.
General Electric Co.
Geophysical Inst. Co.
Metron Instrument
Millers Falls
Olsen Testing Machine
Pacific Scientific
Rutishauser Corp.
Saxl Instrument
Schaevitz Engineering
Statham Labs.
Suter, Alfred
Thwing-Albert
Toledo Scale Co.

TENSION INDICATORS
Baldwin Locomotive
Boulin Instrument
Chatillon & Sons
Cole Instrument
Dillon Co.
Emery Co., A. H.
Federal Products Corp.
General Electric Co.
Geophysical Inst. Co.
Olsen Testing Mach.
Pacific Scientific Co.
Precision Scientific
Saxl Instrument
Seederer-Kohlbusch, Inc.
Wiancko Engineering

Specialized Test Equipment for

Diesel and fuel-injection engine components and auxiliaries ....

•

Universal pump and governor test-stand for all types of high- and low-pressure calibration.

•

Test-stand for single-unit pumps for heavy Diesel both ship and railroad calibrating. (Spec. furnished on both stands on request)

•

Uni-directional unit for counters and tachometers.

•

Spray-nozzle patterns test-stand with Stroboscopic unit.

•

Self-contained fog dispenser unit for nozzle testing.

•

Hydraulic swedger for high-pressure tubing. Also bearing remover.

•

Compact automotive coil condenser and generator tester.

•

FERRIER ENGINEERING

24 Benton St., Springfield, Mass.

OUTSTANDING

VIBROTEST . . . PUSH-BUTTON INSULATION RESISTANCE TESTING

Vibrotest is the fast, accurate way to measure all insulation resistances to 50,000 megohms . . . NO CRANKING OR LEVELING . . . All electric . . . Fully portable . . . Rugged. Only two binding posts for all tests. Several models have A.C. and D.C. volt ranges, as well as low resistance ohmmeter.

Make your insulation resistance testing a "push-button" operation with Vibrotest. Write for Bulletin 2A.

HYPOT . . . HIGH-POTENTIAL INSULATION RESISTANCE TESTING

Hypot Models from small, fully-portable instruments to high-capacity, high-voltage wheeled units. Ranges from 0-1500 V.A.C. at 80 VA. capacity to 0-50,000 V.A.C. at 5 K.W. capacity. Hypot Juniors have separate visual indications for leakage, breakdown or shorts. All models fast and simple to operate; ruggedly built for long, low-cost use. Write for Bulletins 4A and 5A.

VIBROGROUND . . . GROUND RESISTANCE TESTING

Direct readings of true resistance to earth of man-made grounds, soil and earth resistivity with Vibroground testing. No leveling, cranking or outside power source necessary. Light weight, rugged for hardest field service. Models to suit every need. Write for Bulletin 105.

OTHER ARI Precision Instruments include tachometers, limits bridges, phase sequence indicators, volt-ammeters, ohmmeters, current transformers, Keeler Polygraph (Lie Detector), and special instrumentation of many types. Write for details.

ASSOCIATED RESEARCH, Incorporated
"Precision Instruments Since 1936"
3762 West Belmont Avenue, Chicago 18, Illinois

TENSION INDICATORS Textile
Boulin Instrument Corp.
Chatillon & Sons
Dillon & Co.
Federal Products Corp.
General Elec. Co.
Olsen Testing Mach.
Pacific Scientific Co.
Saxl Instrument
Statham Labs.

TEST BLOCKS
Brown & Sharpe
Clarke Instrument
Detroit Testing Mach.
Eastern Specialty Co.
Fonda Gage Co.
General Elec. Co.
Kent Cliff Labs.
Olsen Testing Mach.
States Co.
Steel City Testing Mach.
Van Keuren Co.

TEST BLOCKS (Textile)
Boulin Instrument Corp.

TEST INDICATOR
Ames Co., B. C.
Brown & Sharpe
Deming Indicator Co.
Federal Products Corp.
Gadgets Inc.
Lewis Engineering
Scherr Co., Inc.
Starrett Co.

TEST STANDS, Propeller
Airplane Mfg. & Supply
Falstrom Co.
Gadgets Inc.

TEST WEIGHTS (See Weights, Test)

TEST WELLS (See Thermometer Test Wells)

TESTERS, Abrasion
American Inst. Co.
Amthor Testing Inst. Co.
Atlas Elec. Devices Co.
Baldwin Locomotive
Fidelity Mach. Co.
Gardner Laboratory
General Elec. Co.
Morehouse Machine Co.
Olsen Testing Machine
Riehle Div.
Scott Testers, Inc.
Shawmut Engr. Co.
Suter, Alfred
Taber Instrument Co.
Testing Machines, Inc.
Zuhr, Inc., Henry

TESTERS, Absorption
Burrell Tech. Supply
Gurley, W. & L. E.
Humboldt Mfg. Co.
(Continued)
Nankervis Co., G. L.
Precision Scientific
Testing Machines, Inc.
Willams Apparatus

TESTERS, Air Speed Indicator (See Air Speed Indicator Testers)

TESTERS, Altimeter (See Altimeter Testers)

TESTERS, Armature
Associated Research, Inc.
Communication Meas. Lab.
Instrument Labs.
Schauer Mfg. Co.
Sherron Metallic

TESTERS, Asphalt
American Inst. Co.
Atlas Eectric Devices
Bowen & Co.
Braun Corp.
Central Scientific Co.
Chatillon & Sons
Dillon & Co.
Exact Weight Scale
Fish-Schurman Co.
Fisher Scientific Co.
Humboldt Mfg. Co.
Koehler Instrument
Olsen Testing Mach.
Philadelphia Thermometer
Precision Scientific Co.
Riehle Test. Mach. Div.
Scott Testers, Inc.
Tagliabue Div.
Thwing-Albert Inst.

TESTERS, Axle
Olsen Testing Mach.
Riehle Test. Mach. Co.
Sperry Products, Inc.

TESTERS, Battery
Clough-Brengle Co.
Daven Co.
Edelman & Co.
Electro-Mech. Inst.
Electronic Development
Electronic Instrument
Freas Glass Works
General Electric Co.
Hickok Elec. Inst. Co.
Instrument Labs.
Kimble Glass
Precision Therm.
Rascher & Betzold
Rieker Inst. Co.
Simpson Electric
Sterling Mfg. Co.
Testrite Inst. Co.
Triplett Elec. Inst.
Weston Elec. Inst. Corp.

TESTERS, Bearing
Elgin National Watch
Engineering Res. & Dev.
Physicists Research

TESTERS, Beating
Precision Scientific
Testing Machines, Inc.
Williams Apparatus Co.

TESTERS, Brake
American Inst. Co.
Clough-Brengle Co.
Commercial Research
Cramer & Co., Inc.
Emery Co., A. H.

TESTERS, Camera Shutter
Triumph Mfg. Co.

TESTERS, Chlorine
Everson Mfg. Co.
Hellige, Inc.
Industrial Inst., Inst.
LaMotte Chemical Prods.
Photovolt Corp.
Precision Scientific
Rascher & Betzold
Taylor & Co., W. A.
Wallace & Tiernan

TESTERS, Coal (See Fuel below)

TESTERS, Coil (Electric)
Associated Research
Boonton Radio Corp.
Clippard Inst. Lab.
Clough-Brengle Co.
Cole Instruments
Feiler Engineering
General Elec. Co.
General Radio
Ideal Industries
Industrial Insts., Inc.
Instrument Labs.
Kellogg Switchboard
Panoramic Radio Co.
Radex Corp.
Rubicon Co.
Schauer Mfg. Co.
Sherron Metallic
Technology Instrument
Thordarson Elec. Mfg.
United Transformer

TESTERS, Color
Atlas Electric Devices Co.
Fisher Scientific Co.
Gaertner Scientific Corp.
Gardner Laboratory
General Elec. Co.
Hellige, Inc.
Huggins Labs.
Instrument Dev. Labs.
Photovolt Corp.
Tagliabue Div.

TESTERS, Condenser
Aerovox Corp.
Associated Research
Boonton Radio Corp.
Bradshaw Instruments
Clippard Inst. Lab.
Clough-Brengle Co.
Cornell Dubilier
Electronic Development
Electronic Instrument
Feiler Engineering
Fox Valley Inst.
General Electric Co.
General Radio Co.
Hickok Elec. Instrument
Industrial Insts. Inc.
Instrument Labs.
Jackson Electrical Inst.
Kalbfell Labs., Inc.
Kellogg Switchboard
Potter Co.
Radio City Products
Reiner Electronics
Rubicon Co.
Schauer Mfg. Co.
Sherron Metallic
Tobe Deutschmann Corp.
Triplett Electrical Inst.
Weston Elec. Inst. Corp.
Williams Apparatus

TESTERS, Deflection, Light Wave
Acme Industrial
Bowser, Inc.
Gaertner Scientific Corp.
Sherron Metallic
Van Keuren Co.

TESTERS, Dew Point
Bowser, Inc.
Ferner Co.
General Electric
Instrument Dev. Labs.
Refinery Supply Co.
Tagliabue Div.

TESTERS, Dielectric, Properties
American Transformer Co.
Antenna Research Lab.
Associated Research, Inc.
Boonton Radio Corp.
Cole Instrument
Electronic Dev. Lab.
General Elec. Co.
General Radio
Instrument Labs.
Leeds & Northrup Co.
Miller Co., B. F.
Roller-Smith
Sherron Metallic
Tagliabue Div.
Westinghouse Elec.
Winslow Co.

TESTERS, Electroplating (See Electroplating Solution Testing Apparatus)

TESTERS, Emulsion & Demulsibility
Central Scientific Co.
Precision Scientific

TESTERS, Expansion
Dietert Co.
Dillon & Co.
Exact Weight Scale Co.
Ferner Co.
Humboldt Mfg. Co.
Gaertner Scientific Corp.
Thwing-Albert Inst. Co.

TESTERS, Fading
Atlas Elec. Devices Co.
Gen. Elec. Vapor Lamp

TESTERS, Flash Point, Abel-Pensky's (See Abel's above)

TESTERS, Flash Point, Cleveland Open Cup
American Inst. Co.
Boekel & Co.
Central Scientific Co.
Humboldt Mfg. Co.
Koehler Instrument
Olsen Testing Machine
Precision Scientific Co.
Ruehfel Co.
Tagliabue Div.

TESTERS, Flash Point, Elliott Closed Cup
American Inst. Co.
Central Scientific Co.
Humboldt Mfg. Co.
Precision Scientific Co.
Ruehfel Co.
Tagliabue Div.

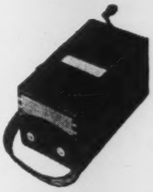
TESTERS, Flash Point, Pensky-Martens
American Inst. Co.
Boekel & Co.
Central Scientific Co.
Humboldt Mfg. Co.
Koehler Instrument
Precision Scientific Co.
Ruehfel Co.
Tagliabue Div.

TESTERS, Flash Point, Tag Closed
Central Scientific Co.
Humboldt Mfg. Co.
Koehler Instrument
Precision Scientific Co.
Ruehfel Co.
Tagliabue Div.

TESTERS, Flatness, Light Wave
Acme Scientific
Baird Associates
Bausch & Lomb
Crystal Research Labs.
Fecker, J. W.
Fish-Schurman Co.
Gaertner Scientific Co.
Geophysical Inst. Co.
Howland Optical
Optron Laboratory
Scherr Co., Inc.
Sherron Metallic
Van Keuren Co.
Zeiss, Inc., Carl

"MEGOHMER" INSULATION TESTERS

GENERATOR TYPES



MINOR

Dwarf size, 0-10 or 0-20 or 0-50 megohms, variable pressure, 500 Volts D.C. Bulletin 450.

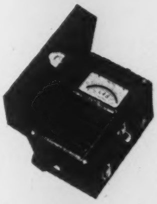
MAJOR

0-50 megohms with extra ohm scale, 0-30 or 0-10,000 ohms, constant pressure, 500 Volts D.C. Bulletin 465.

STANDARD

Heavy duty type, 500 or 1000 Volts D.C., constant pressure. Ranges up to 2000 megohms. Double and triple range. Bulletin 455.

BATTERY VIBRATOR TYPES



MODEL B-7

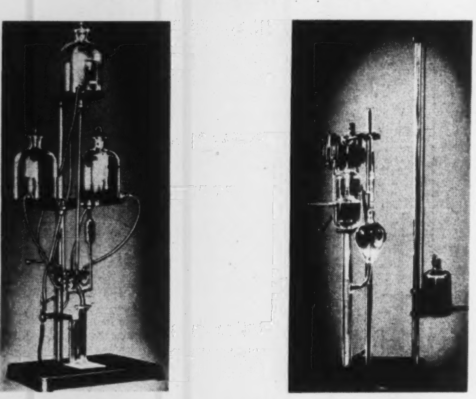
Four ranges in one instrument: 0-20/200 megohms, 0-200/20,000 ohms. Two test potentials: 250 and 500 Volts D.C. Bulletin 440.

MODEL B-6

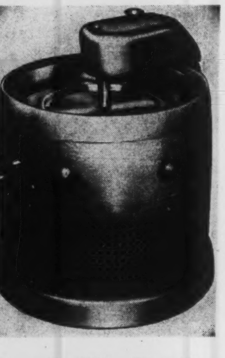
Four instruments in one. Six ranges: 0-200 megohms, 0-2000 ohms, 0-150/600 Volts A.C., 0-150/300 Volts D.C. Bulletin 441.

HERMAN H. STICHT CO., INC.
27 PARK PLACE NEW YORK 7 N Y

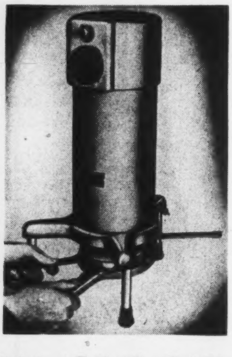
Testing and Control
Instruments and Equipment
for Moisture, Carbon, Sulfur, Sand,
Micro-Particle Size



Two-Minute Carbon and Sulfur Determinators
For Metals and Organic Materials



Micro-Particle Classifier for Classification of Fine Materials.



Moisture Teller for Quickly and Accurately Determining the Moisture Content of all types of Material.

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9330 Roselawn Avenue
Detroit 4, Michigan

TESTERS, Fluorescent Lighting
Eitzen Company
Littelfuse, Inc.
Skaneateles Mfg.
Sylvania Elec. Prod.

TESTERS, Freeness
Bristol Co.
Dietert Co.
Testing Machines, Inc.
Williams Apparatus Co.

TESTERS, Fuel
American Inst. Co.
Burrell Technical Supply
Central Scientific Co.
Cuthbert Co.
Emerson Apparatus Co.
Fish-Schurman Co.
Fisher Scientific Co.
Parr Instrument Co.
Phillips Petroleum
Precision Scientific
Riehle Div.
Sargent & Co.
Sturtevant Mill
Testing Machines, Inc.

TESTERS Gage (See Gage Testers)

TESTERS, Gas (See Gas Analyzers)

TESTERS, Gear
Dillon & Co.
Engineering Res. & Dev.
Fellows Gear Shaper
Ferner Co.
Krouse Testing Mach.
Morse Twist Drill
Olsen Testing Mach.
Scherr Co., Inc.

TESTERS, Glue
Central Scientific Co.
Dillon & Co.
Fish-Schurman Co.
Olsen Testing Machine
Physicists Research
Thwing-Albert Inst. Co.

TESTERS, Grain
Central Scientific Co.
Cuthbert Co.
Exact Weight Scale
Gump Co.
Menlo Research Lab.
Moist-O-Meter, Inc.
Moisture Register Co.

(Continued)

Newark Scale Works
Precision Scientific Co.
Seedburo Equipment
Tagliabue Div.
Toledo Scale Co.
Troemner, Henry

TESTERS, Grease (See Grease Testing Apparatus)

TESTERS, Grinding Wheel
Olsen Testing Machine

TESTERS, Ground Resistance
Associated Research
Automatic Electric Sales
Biddle Co., Jas. G.
Borden Engineering
General Electric Co.
Geophysical Inst. Co.
Gray Instrument
Heiland Research
Industrial Insts., Inc.
Instrument Labs.
Leeds & Northrup
Miller, M. C.
Niagra Electric
Roller Smith
Sensitive Res. Inst.

(Continued)

Shallcross Mfg.
Sherron Metallic
Sticht & Co.
Thwing-Albert
Winslow Co.

TESTERS, Hardness of Grindable Materials
Ames Precision Machine
Ferner Co.
Gardner Laboratory
Gordon Co., Claud S.
Riehle Testing Machines

TESTERS, Hardness of Plastic Films
Ferner Co.
Gordon Co., Claud S.
Munsell Color Co.
Precision Scientific
Steel City Testing
Taber Instrument Co.
Testing Machines, Inc.

TESTERS, High Altitude (See Chambers, Instrument Test)

TESTERS, Hydrogen - Ion (See Hydrogen-Ion Determination Instruments)

TESTERS, Insulation
Aircraft Electronics
American Transformer
Antenna Research Lab.
Associated Research
Automatic Elec. Chicago
Biddle Co., Jas. G.
Boonton Radio Corp.
Clough-Brengle Co.
Cole Instrument
Communication Meas. Lab
Dice Co., J. W.
Freed Transformer
General Elec. Co.
General Radio Co.
Geier & Bluhm
Hewlett-Packard
Hickok Elec. Inst.
Ideal Industries, Inc.
Industrial Insts., Inc.
Islip Radio Mfg.
Kellogg Switchboard
Leeds & Northrup Co.
Miller Co., Bertrand F.
Precise Measurements Co.
Radio Frequency Labs.
Rawson Electrical Inst.
Rubicon Co.
Scott Testers
Shallcross Mfg. Co.
Sherron Metallic
States Co.
Sticht Co.
Superior Insts.
Westinghouse Elec.
Weston Elec. Inst.
Winslow Co.

TESTERS, Insulation (Thickness)
Comtor Co.
Federal Products Corp.
General Elec. Co.

TESTERS, Jelly
Chatillon & Sons
Fish-Schurman Co.
Koehler Instrument
Precision Scientific

TESTERS, Laundering
Atlas Electric Devices

TESTERS, Lens
Engis Equipment
Gaertner Scientific
Mann Co., W. I.

TESTERS, Magnetic
Aero Electronics
American Inst. Co.
Annis Co.
Associated Research
Baird Associates
Dice Co., J. W.
General Elec. Co.
General Radio
Geophysical Inst. Co.
Instrument Labs.
Magnaflux Corp.
Magnetic Analysis Corp.
Pioneer Instrument
Rawson Elec. Instr. Co.
Rubicon Co.
Ruska Inst. Corp.
Sherron Metallic

TESTERS, Malt
Brabender Corp.
Rieker Instrument Co.
Seedburo Equipment

TESTERS, Mica
Boonton Radio Corp.

TESTERS, Mileage (See Meters, Mileage)

TESTERS, Milk
Central Scientific Co.
Kimble Glass
Koehler Instrument
Munsell Color Co., Inc.
Photovolt Corp.
Rieker Inst. Co.
Ruehfel Co.
Scientific Glass App.
Standard Elec. Time
Testrite Instrument Co.
Tagliabue Div.

TESTERS, Moisture
Aero Electronics
Alpha-Lux Co.
American Inst. Co.
Brabender Corp.
Brown Inst. Div.
Burrows Equipment Co.
Cambridge Inst. Co.
Central Scientific Co.
Cuthbert Co.
Delmhorst Instrument
Dietert Co.
Electronic Products Co.
Exact Weight Scale
Ferner Co.
Fielden Instrument
Fisher Scientific Co.
Food Technology, Inc.
General Elec. Co.
Hart Moisture Gages
H & H Thermostats
Humboldt Mfg. Co.
Industrial Inst., Inc.
Laboratory Equipment
Moisture Register Co.
Precision Scientific Co.
Rascher & Betzold
Refinery Supply Co.
Scientific Glass App.
Scientific Inst. (Detroit)
Seedburo Equipment
Shallcross Mfg. Co.
Tagliabue Div.
Tenney Engineering
Testing Machines, Inc.
Thwing-Albert Inst. Co.
Toledo Scale Co.
Troemner, Henry
Williams Apparatus Co.

TESTERS, Mullen
Testing Machines

TESTERS, Non destructive electrical for physical properties
Aero Electronics
Baldwin-Lima-Hamilton
Cady & Co.
Cole Instrument
Dice Co., J. W.
Electro Products Labs.
Ferner Co.
General Electric
General Radio
Hathaway Instrument
Magnaflux Corp.
Sheffield Corp.
Sperry Products
Thwing-Albert Inst. Co.

TESTERS, Oil
American Inst. Co.
Central Scientific Co.
Eitzen Co.
Fish-Schurman Co.
Gardner Laboratory
Gerin Corp.
Hellige, Inc.
Humboldt Mfg. Co.
Kimble Glass
Koehler Instrument
Laboratory Equipment
Menlo Research Lab.
Mico Instrument Co.
Precision Scientific Co.
Refrigeration Sys.
Rieker Inst. Co.
Ruehfel Co.
Ruska & Co.
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Div.
Tenney Engineering

TESTERS, Oxygen
American Inst. Co.
Burrell Technical Supply
Central Scientific
Gadgets, Inc.
General Elec. Co.
Precision Scientific
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Div.

TESTERS, Paint
American Inst. Co.
Atlas Elec. Devices Co.
Boonton Radio Corp.
Central Scientific Co.
Dillon & Co.
Fish-Schurman Co.
Gardner Laboratory
General Elec. Co.
Instron Engg. Corp.
Koehler Instrument
Munsell Color Co.
Photovolt Corp.
Precision Scientific
Ruehfel Co.
Scott Testers
Taber Instrument Co.
Tenney Engineering
Thermo-Electric
Van Keuren Co.
Zuhr. Inc., Henry

TESTERS, Paper Curl
Thwing-Albert Inst. Co.

TESTERS, Paper Formation
Dillon & Co.
General Elec. Co.
Hart Moisture Gages
Testing Machines, Inc.
Thwing-Albert Inst. Co.
Williams Apparatus Co.

TESTERS, Paraffin
American Inst. Co.
Humboldt Mfg.
Koehler Instrument
Olsen Testing Mach.
Perkins & Son
Precision Scientific
Ruehfel Co.
Tagliabue Div.

TESTERS, Penetration (Paper)
General Electric
Olsen Testing Mach.
Riehle Testing Machines
Testing Machines, Inc.
Thwing-Albert Inst. Co.
Williams Apparatus Co.

TESTERS, Petroleum (See Oil above)

TESTERS, Phosphate
Hellige, Inc.
La Motte Chemical Prods.
Permutit Co.
Taylor & Co., W. A.

TESTERS, Pistol Barrel Optical
Kollmorgan Optical Co.
Lenox Inst. Co.
Scherr Co., Inc.
Schneider-Cogswell

TESTERS, Piston Ring
American Measuring Insts.
Gordon Co., Claud S.
Link Engineering
Toledo Scale Co.

TESTERS, Pitch
American Inst. Co.
Precision Scientific Co.

TESTERS, Plasticity
American Inst. Co.
Brabender Corp.
Dietert Co.
Dillon & Co.
Humboldt Mfg. Co.
Instron Eng. Corp.
Olsen Testing Machine
Precision Scientific Co.
Scott Testers, Inc.
Steel City Testing
Testing Machines, Inc.

TESTERS, Porosity
Ferner Co.
Gurley, W. & L. E.
Magnaflux Corp.
Perkins & Son
Precision Scientific
Ruska Instrument
Saxl Instrument
Testing Machines, Inc.
Thwing-Albert Inst. Co.
Westinghouse Elec.
Williams Apparatus Co.

TESTERS, Pulp
Hart Moisture Gage
Perkins & Son
Testing Machines, Inc.
Thwing-Albert Inst. Co.
Williams Apparatus Co.

TESTERS, Radio Set (See Analyzers, Radio Set)

TESTERS, Radio Tube (See Analyzers, Radio Set)

TESTERS, Relay
Arthur E. Booth
Eastern Specialty Co.
Electro-Physics
Standard Elec. Time
Weston Elec. Inst.
TESTERS, Resistance
Assembly Products
Associated Research, Inc.
Automatic Elec. Chicago
Beckman Instruments
Biddle Co., James G.
Boonton Radio Corp.
Borden Engineering
Brown Electro-Measurement
Cole Instrument
Communication Meas. Lab.
Dale Instruments
Electro-Tech Equipment
Electronic Dev. Lab.
Electronic Instrument
Feller Engineering
Freed Transformer
General Elec. Co.
General Radio Co.
Gray Instrument Co.
Ideal Industries, Inc.
Industrial Instruments
Instrument Labs.
Leeds & Northrup Co.
Nosker Eng. Prod.
Radex Corp.
RCA
Riehle Testing Machines
Rubicon Co.
Shallcross Mfg. Co.
Simpson Electric
Sticht Co.
Supreme Instrument Corp.
Sylvania Elec. Prod.
Triplett Electrical Inst.
Westinghouse Elec.
Weston Electrical Inst.

TESTERS, Salt Spray
American Instrument Co.
Atlas Electric Devices
Industrial Filter

TESTERS, Sand
Chatillon & Sons
Dietert Co.
Exact Weight Scale Co.
Hart Moisture Gage
Humboldt Mfg. Co.
Precision Scientific

TESTERS, Shutter
Amer. Chronoscope
Triumph Mfg. Co.

TESTERS, Slowness
Testing Machines, Inc.
Williams Apparatus Co.

TESTERS, Softness
Dillon & Co.
Ferner Co.
Gurley, W. & L. E.
Humboldt Mfg. Co.
Olsen Testing Mach.
Precision Scientific
Riehle Testing Machines
Taber Instrument Co.
Thwing-Albert Inst. Co.

TESTERS, Soil
American Instrument
Associated Research
Kauffman-Lattimer
LaMotte Chemical Prod.
La Pine & Co., A. S.
Marconi Instruments Ltd.
Miller, M. C.

TESTERS, Spark Plug
Beam Instrument
Centralab Div.
Cole Instrument
General Cement Mfg.
Hickok Elec. Inst.
Schauer Mfg. Co.

TESTERS, Strain (Glass)
Baird Associates
Bausch & Lomb Opt.
Edin Electronics
Fecker, J. W.
Fish-Schurman Corp.
Gaertner Scientific Corp.
General Elec. Co.
Hathaway Instrument
Kollmorgan Optical Co.
Olsen Testing Mach.
Pfaltz & Bauer, Inc.
Plummer & Kershaw
Polarizing Instrument Co.
Precision Scientific
Zeiss, Inc., Carl

TESTERS, Tachometer
American Time Prods.
Amthor Testing Inst.
Associated Research
Biddle Co., Jas. G.
Consol. Ashcroft Hancock
Elec. Tachometer Corp.
(Continued)
Engineering Res. & Dev.
Flader Inc. Fredric
Gadgets Inc.
General Elec. Co.
Globe Industries
Ideal Lab. Tool
Pioneer Instrument
Precision Scientific
Rieker Inst. Co.
Rowe Engineering
Standard Elec. Time
Sticht Co.
Sun Manufacturing
Zeiss, Inc., Carl
Zernickow Co., O.

TESTERS, Tenderness
American Inst. Co.
Humboldt Mfg. Co.
Precision Scientific Co.

TESTERS, Thermometer
Amthor Testing Inst.
Consol. Ashcroft Hancock
Freas Glass Works
G. M. Mfg. Co.
Green, Henry J.
Ideal Lab. Tool
J-B-T Instruments
Kahl Scientific Inst.
Hiergesell & Sons
Huddleston, J. S. F.
Lewis Engineering
Manning, Maxwell, Moore
Moeller Instrument Co.
Nurnberg Thermometer
Palmer Co.
Ruehfel Co.
Schultheis Corp.
Tagliabue Div.
Thwing-Albert Inst. Co.
Wagner & Son
Weksler Thermometer

TESTERS, Torque and Torque Wrench
Airdraulics Engineering
Chatillon & Sons
Edin Electronics
Genisco Inc.
Olsen Testing Mach.
Skyway Precision Tool
Sturtevant Co.

TESTERS, Turn Indicator
Amthor Testing Inst. Co.
General Electric Co.
Genisco Inc.
Globe Industries
Ideal Lab. Tool
Pioneer Instrument
Rieker Instrument Co.
Ruehfel Co.
Standard Products
Summers Gyroscope

TESTERS, Ultrasonic
Audio-Tone Oscillator
Branson Instruments, Inc.
Dice Co., J. W.
Gen. Precision Lab.
Gulton Mfg. Co.
Radioactive Products
Sperry Products

TESTERS, Vapor Transmission
Thwing-Albert Inst. Co.

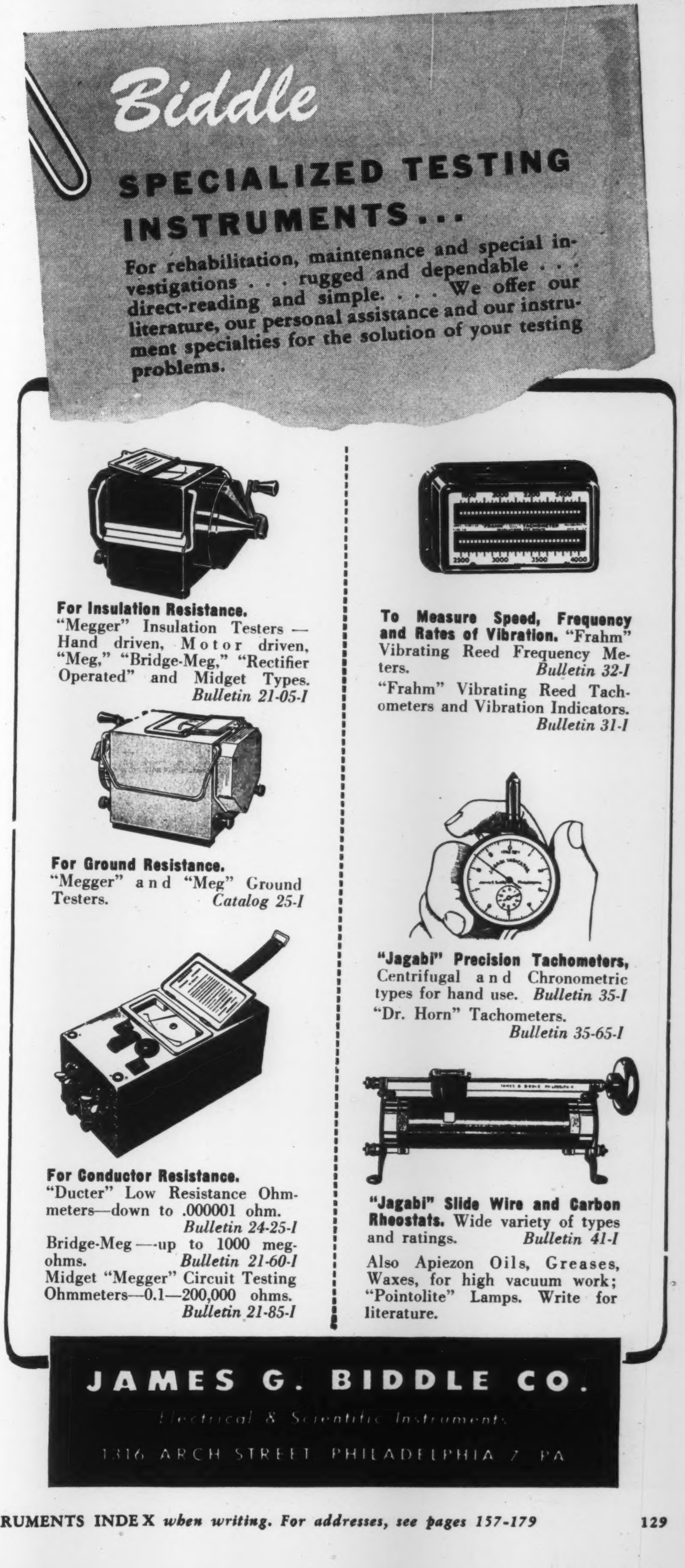
TESTERS, Varnish
Atlas Elec. Devices Co.
Dillon & Co.
Fish-Schurman Co.
Gardner Laboratory
Hellige, Inc.
Photovolt Corp.
Scott Testers
Taber Instrument Co.
Thermo Electric Co.
Zuhr, Inc., Henry

TESTERS, Voltage
Antenna Research Lab.
Associated Research
Ballantine Labs.
Clough-Brengle Co.
Cole Instrument
Electrical Facilities, Inc.
Electronic Associates
Electronic Dev. Lab.
Esterline-Angus
Feiler Engineering
Fox Valley Inst.
General Elec. Co.
Ideal Industries, Inc.
Instrument Labs.
Islip Radio Mfg.
Lyman Electronic
MacLeod & Hanopol
Norton Electrical Inst.
Precise Measurements
Precision Apparatus
Potter Co.
RCA
Shallcross Mfg. Co.
Sherron Metallic
Standard Products Inc.
Sticht Co.
Sylvania Elec. Prod.
Trenton Transformer
Triplett Elec. Inst.

TESTERS, Watch Rate
American Time Prods.
Paulson & Co.
Potter Instrument

TESTERS, Water Meter
Badger Meter Co.
Barnstead Still
Exact Weight Scale
Fischer & Porter
Neptune Meter Co.
Toledo Scale Co.

TESTERS, Water Penetration
Biddle Co., Jas. G.
Hart Moisture Gage
Thwing-Albert Inst. Co.
Williams Apparatus
TESTERS, Watthour Meter
Duncan Elec. Mfg.
Eastern Specialty Co.
(Continued)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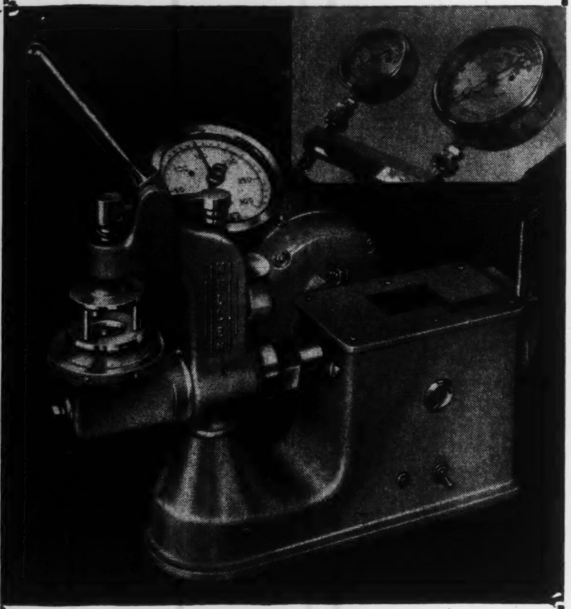

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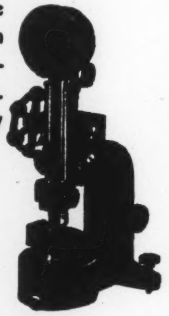

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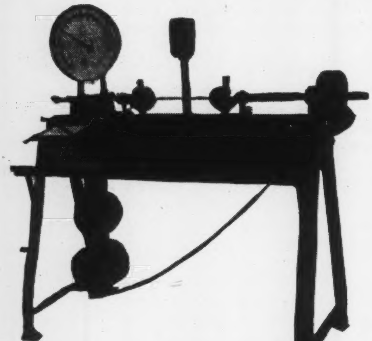

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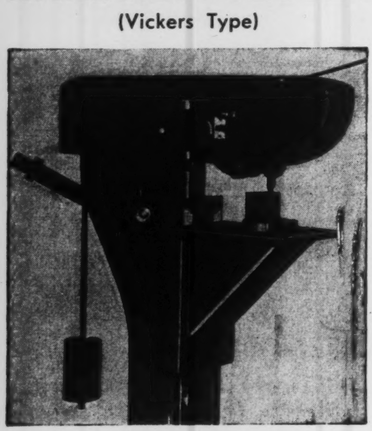

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Brown Inst. Div.
Chatillon & Son
Dillon & Co.
Emerson Apparatus Co.
Hart Moisture Gage
Instron Eng. Corp.
Olsen Testing Mach.
Saxl Instrument
Schaevitz Engineering
Scott Testers, Inc.
Suter, Alfred
Testing Machines, Inc.
Thwing-Albert Inst. Co.

TESTING SETS (See also object of measurement and control)

TESTING SETS, Alcohol
Fischer & Porter
G. M. Mfg. Co., Inc.
Griebel Co.
Kahl Scientific Inst.
Precision Therm.
Rascher & Betzold
Ruehfel Co.
Scientific Glass App.
Tagliabue Div.
Weksler Thermometer

TESTING SETS, Automotive
Beam Instrument
Clough-Brengle Co.
Englehard Chas.
Fox Valley Inst.
Gow-Mac Instrument
Hays Corp.
Neihoff & Co.
Potter Co.
Westberg Mfg. Co.

TESTING SETS, Cable
Automatic Elec. Chicago
Biddle Co., James G.
Century Geophysical
Communication Meas. Lab.
Eastern Specialty
Feiler Engineering
General Elec. Co.
General Radio Co.
Leeds & Northrup
Littlefuse, Inc.
Rubicon Co.
Shallcross Mfg.
Sherron Metallic
Westinghouse Elec.
Winslow Co.

TESTING SETS, Communication Circuits
Automatic Elec. Chicago
Bell & Howell
Clough-Brengle
Collins Radio Co.
Daven Co.
Electronic Dec. Lab.
Electro Products Labs.
Feiler Engineering
Freed Transformer
Hewlett-Packard
Kellogg Switchboard
Leeds & Northrup
Littlefuse, Inc.
Meters, Inc.
Precision Apparatus
Radio City Products
Reiner Electronics
Rubicon Co.
Shallcross Mfg.
Sherron Metallic
Simpson Electric
Sylvania Elec. Prod.
Technology Inst. Corp.
Weston Elec. Inst. Corp.
Winslow Co.

TESTING SETS, Current Transformer
Assembly Products
Elec. Facilities Inc.
Federal Telegraph Co.
Feiler Engineering
General Electric Co.
Leeds & Northrup
Rubicon Co.
Sherron Metallic
States Co.
Thordarson Elec. Mfg.

TESTING SETS, Electrical
Aero Electronics
American Transformer
Associated Research
Automatic Elec. Chicago
Biddle Co., James G.
Bradshaw Instruments
Clarke Inst. Corp.
Clough-Brengle Co.
Columbia Elec. Mfg.
Communication Meas. Lab.
Dale Instruments
Dice Co., J. W.
Eastern Specialty
Elec. Facilities, Inc.
Electronic Dev. Lab.
Electronic Instrument

(Continued)

Esterline-Angus
Feiler Engineering
Gadgets Inc.
General Elec. Co.
Gray Instrument
Hewlett-Packard
Industrial Inst., Inc.
Kay Electric
Link Engineering
Meter Devices Co.
Potter Instrument
Precision Apparatus
Rawson Elec. Inst. Co.
RCA Mfg. Co.
Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co
Sherron Metallic
Sticht Co
Superior Electric Co
Tobe Deutschmann Corp.
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.
Winslow Co.

TESTING SETS, Electrical Thermometer
Brown Inst. Div.
Feiler Engineering
Gadget Inc.
Gray Instrument
Leeds & Northrup
Rubicon Co.
Shallcross Mfg. Co.
Sherron Metallic
Tagliabue Div.
Thwing-Albert Instrument
Winslow Co.

TESTING SETS, Ground Resistance (See Tester, Ground Resistance)

TESTING SETS, Insulation, (see Testers, Insulation)

TESTING SETS, Line Current
Associated Research
Automatic Elec. Chicago
Cole Instrument
Columbia Elec. Mfg.
Elec. Facilities, Inc.
Electronic Development
Esterline Angus
Feiler Engineering
General Elec. Co.
Gray Instrument
Hickok Elec. Inst.
Meter Devices Co.
Precision Apparatus
Roller-Smith
Rubicon Co.
Sherron Metallic
Sticht Co.
Triplett Elec. Inst.
Weston Elec. Inst. Corp.

TESTING SETS, Meters, Electrical
Assembly Products
Associated Research
Automatic Elec. Chicago
Beckman Instruments
Booth Co., Arthur H.
Chicago Indust. Inst.
Clippard Inst. Lab.
Clough-Brengle Co.
Cole Instrument
Douglas Radio Labs.
Eastern Specialty Co.
Elec. Facilities, Inc.
Electronic Dev. Lab.
Esterline Angus
Feiler Engineering
General Elec. Co.
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Rawson Elec. Inst. Co.
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Reiner Electronics
Roller-Smith
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
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States Co.
Sticht Co.
Stratex Instrument Co.
Thwing-Albert Inst. Co.
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst. Co.

TESTING SETS, Meters, Fluid
American Meter Co.
Bailey Meter Co.
Fischer & Porter
Tagliabue Div.

TESTING SETS, Portable Combustion
Dwyer Mfg. Co.
Engelhard, Chas.
Hays Corp.

TESTING SETS, Potential transformer
Eastern Specialty Co.
Elec. Facilities, Inc.
General Elec. Co.
Leeds & Northrup Co.
Raytheon Mfg. Co.
Sherron Metallic

TESTING SETS, Surface Roughness
Surface Checking Gage

TESTING SETS, Telephone
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Bradshaw Instruments
Daven Co.
Electronic Development
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Rubicon Co.
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Scientific Glass App.
Taylor & Co., W. A.

TESTING SIEVE SHAKER (See Sieve Shakers)

TESTING SIEVES (See Sieves, Testing)

THEODOLITES (See Surveying Instruments)

THEODOLITES, Magnetic
Gurley, W. & L. E.
Ruska Inst. Corp.

THEODOLITES, Pilot Balloon
White Co., Inc., David

THERMIONIC RECTIFIERS (See Rectifiers, Thermionic)

THERMO-AMMETERS (See Ammeters, Thermo)

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Pyrometer Instrument Co.
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Tagliabue Div.
Thermo Electric Co.

THERMOCOUPLES, Base Metal
Airflo Instrument Co.
Assembly Products
Bailey Meter Co.
Bacharach Industrial Inst.
Bristol Co.
Burlington Inst. Co.
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Cole Instrument
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General Controls
General Elec. Co.
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Gordon Machine & Tool
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Marshall Co., L. H.
Meters, Inc.
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Thermo-Elec. Co.
Taco West Corp.
Tagliabue Div.
Taylor Inst. Cos.
Thermo Electric Co.
Thwing-Albert Instrument
Westinghouse Elec.
Wheelco Inst. Co.
Winslow Co.

THERMOCOUPLES, Contact Type
Amer. Thermo-Elec.
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
Campbell Co., J. A.
Cannon Electric
Cole Instrument
De Jur-Amsco
Elematic Equip. Corp.
Engelhard, Charles
Fillo Sls. & Engr. Co.
General Controls Co.
General Electric
Gordon Co., Claud S.
Hickok Elec. Inst. Co.
Ill. Testing Labs.
J-B-T Instruments
Lewis Engg. Co.
Phen-Trols, Inc.
Precision Tube Co.
Pyrometer Instrument
Pyrometer Service Co.
Revere Corp.
Rowe Engineering
Sensitive Research Inst
Taco West Corp.
Tagliabue Div.
Thermo Electric Co.
Thwing-Albert Instrument
Wheelco Inst. Co.
Winslow Co.

THERMOCOUPLES, Rare-metal (See Base Metal above)

THERMOCOUPLES, Separate Heater Type
Amer. Thermo-Elec.
Beam Instrument
Campell Co., J. A.
Cole Instrument
Electro-Tech Equip. Co.
General Controls
General Elec. Co.
General Radio Co.
Illinois Testing Labs.
Sensitive Research Inst.
Taco West Corp.
Wheelco Insts. Co.

THERMOCOUPLES, Vacuum
Amer. Thermo-Elec.
Beam Instrument
Beckman Instruments
Biddle Co., James G.
Cambridge Inst. Co.
Cole Instrument
Distillation Products
Farrand Optical
Fredericks Co., George
Field Electric
General Elec. Co.
General Radio Co.
Hastings Instrument
Hickok Elec. Inst. Co.
National Research
Perkins Elmer Corp.
Phen-Trols, Inc.
Pyrometer Instrument
Rawson Elec. Inst. Co.
Reeder & Co., Charles
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THERMO-HYDROMETERS (See Hydrometers, Indicating)

THERMOMETER TESTERS (See Testers, Thermometer)

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THERMOMETERS, Indicating, Electrical Resistance
Am. Temperature Ind.
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Bristol Co.
Cole Instrument
De Jur-Amsco Corp.
Edison Inc., Thomas A.
Electric Auto-Lite
Engelhard, Chas.
Foxboro Co.
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Roller-Smith Co.
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Stewart, M. C.
Taco West Corp.
Tagliabue Div.
Thwing-Albert Instrument
Trans-Sonics, Inc.
Trerice Co.
Triplett Elec. Inst.
Weiler, Paul G.
Wheelco Inst. Co.
Weston Elec. Inst. Corp.
Winslow Co.

THERMOMETERS, Indicating, Mechanical
American Temp. Ind.
Bacharach Ind. Inst.
Bailey Meter Co.
Bristol Co.
Defender Insts. & Reg.
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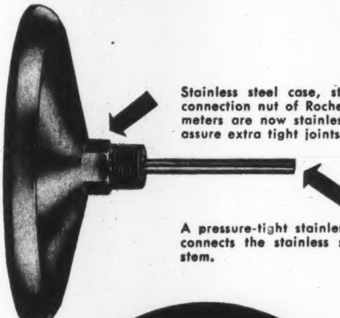
Rochester Announces

AN ALL STAINLESS STEEL INDUSTRIAL THERMOMETER

More durable . . . more pressure-tight . . . more resistant to corrosion



Stainless steel case, stem, bushing and connection nut of Rochester Dial Thermometers are now stainless steel welded to assure extra tight joints

A pressure-tight stainless steel weld also connects the stainless steel plug to the stem.

120
150
90
Rochester
THERMOMETER
180
60
F
210
30
240

Here is a dial thermometer designed especially for heavy-duty petroleum and chemical processing service.

Rochester's new process for welding stainless steel makes it possible to offer you an industrial thermometer that is more pressure-tight than ever before. More resistant to corrosion, too, because the use of silver solder has been completely eliminated.

Welded at the connection nut joining the case and stem and at the plug end of the stem, all exposed parts are made of high quality stainless steel for longer durability.

OTHER ADVANTAGES

A new precision bi-metallic element assures high sensitivity—quick reaction to temperature changes. It is free from pointer vibration and highly accurate—even under extreme temperature variations.

Rochester Thermometers have large dials with big, bold characters that enable you to take readings easily . . . *at a glance.* There's no squinting at hard-to-see mercury columns.

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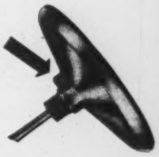

To assure permanent accuracy, Rochester Dial Thermometers are available with a screw adjustment that permits easy recalibration—right on the job. You just put the instrument in boiling water or other known temperature and reset the indicator.

This unique feature compensates for abuse and accidents . . . like dropping or banging a thermometer sufficiently hard to make readings inaccurate . . . which could result in costly production errors.

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-50 to 120° F.	50 to 350° F.	-70 to 160° C.	-90 to 130° F.
-70 to 150° F.	0 to 500° F.	-10 to 110° C.	70 to 56° C.
0 to 200° F.	150 to 750° F.	0 to 150° C.	
0 to 300° F.	*200 to 1000° F.	0 to 300° C.	
30 to 240° F.	....	100 to 400° C.	

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Rochester Thermometers are backed by more than 35 years experience in making dependable automotive and industrial instruments.

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100
110
120
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80
70
60
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140
150
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THE POWERS DIAL THERMOMETER
FAHRENHEIT
THE POWERS REGULATOR CO. CHICAGO NEW YORK
EASY To READ At a Distance
Variety of Ranges

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Help Cut Costs—

For more accurate temperature readings and improved efficiency use POWERS Dial Thermometers. They're vapor pressure actuated. Have 4" dials with either rigid stem for use in pipe lines and tanks or flexible tubing type for conveniently showing the temperature at a remote point.

Phone or write nearest office for Bulletin 355.

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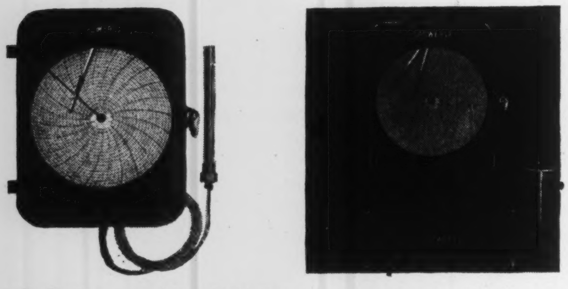

Left: **Single pen recorder.** ***Right:*** **Room type recording psychrometer for wet and dry bulb recording of temperature and humidity.**

The Powers Series 100 thermometers above are available in a wide selection of convenient ranges within the temperature limits of −100°F and +1000°F. Recording thermometers can be furnished in single-pen and two-pen models, using a 12-inch diameter chart having a full 5-inch pen travel; also—*Recording Psychrometers* with an automatic float water pan for dry and wet bulb recordings in ducts or with blower unit and water bottle, panel mounted for use in rooms. Phone or write for Bulletin 370.

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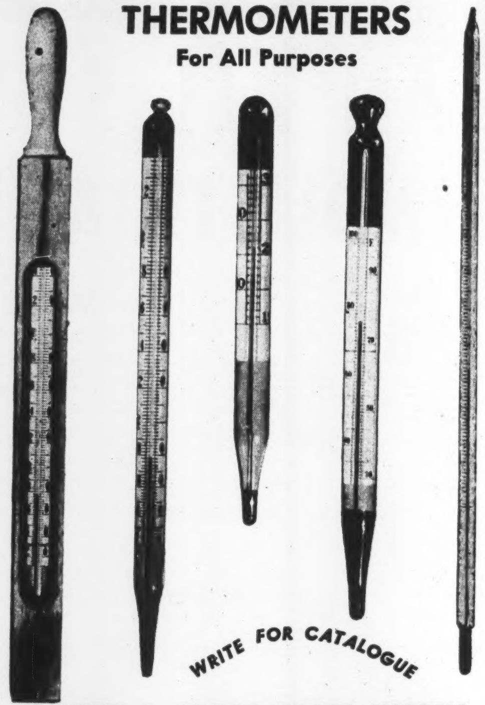
For All Purposes



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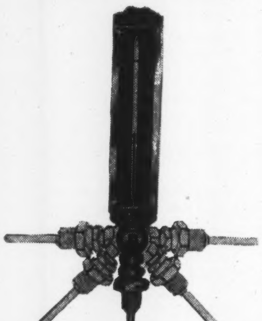

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Simplifies maintenance, reduces replacement stock, easy installation. Supplied with interchangeable socket or other fittings. 7", 9" or 12" case. 3½" to 30" stem. One of a complete range of Weksler instruments for measuring and recording Temperature, Pressure or Humidity.

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Seedburo Equipment
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Tagliabue Div.
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Trerice Co.
U. S. Gauge
Wagner & Son
Weksler Thermometer

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Preferred Utilities Mfg.
Republic Flow Meters
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Scientific Inst. Co.
Standard Thermometer
Tagliabue Div.
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Trerice Co
United States Gauge
Weksler Thermometer
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Welch Scientific

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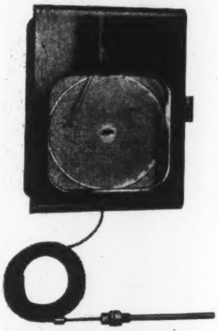

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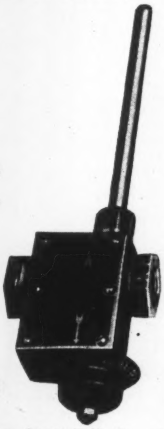

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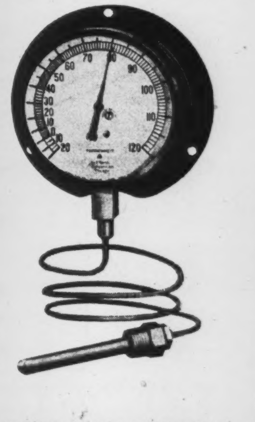

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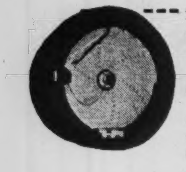
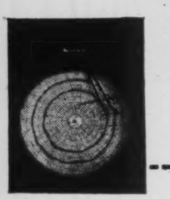
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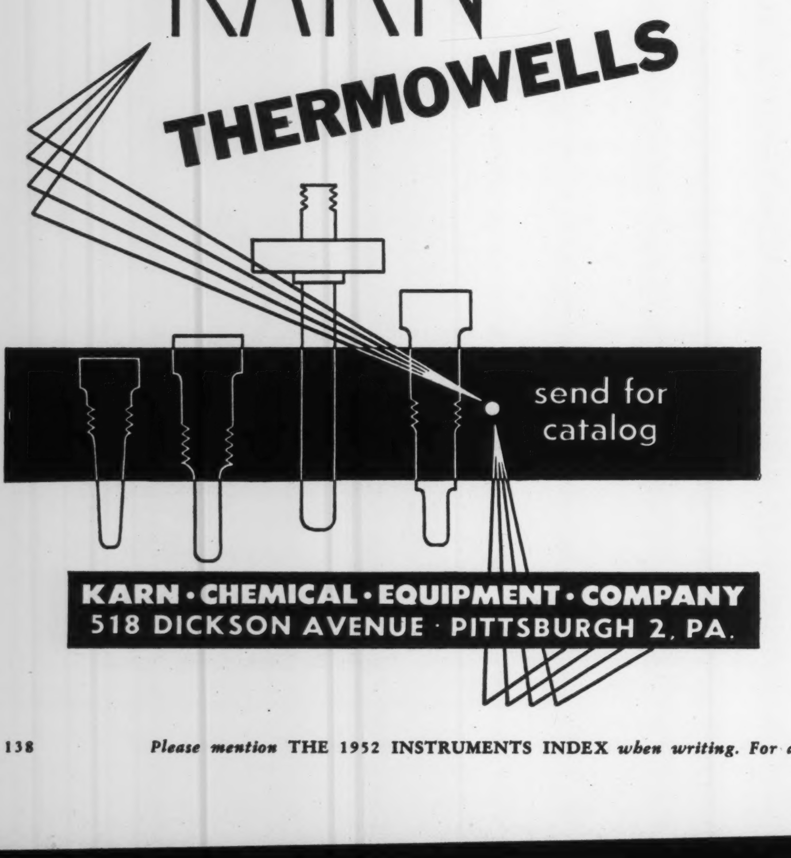

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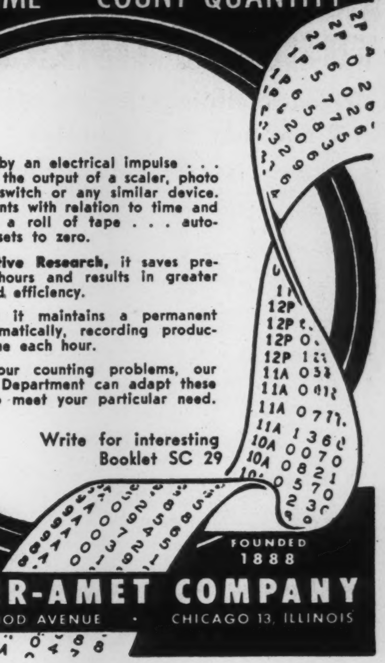

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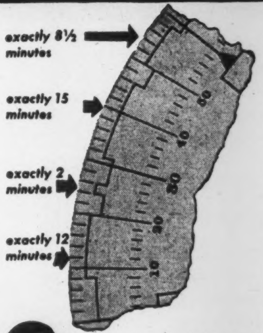

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The *Servis Recorder* checks on this—it records just what happened—it "*times the process.*" You are no longer in the dark; from now on you know all day and every day whether your *process timing* is lived up to—or if somebody slipped—if something went wrong to ruin your product for that afternoon, or that whole shift! Write for Process Timing Catalog. The Service Recorder Co., 1375 Euclid Avenue, Cleveland 15, Ohio.

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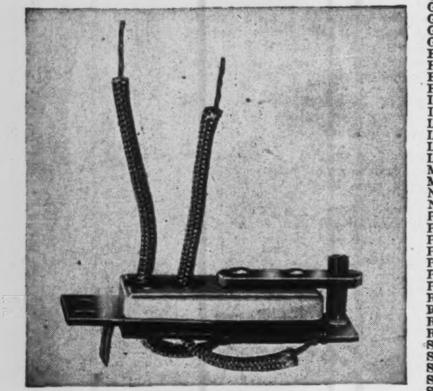

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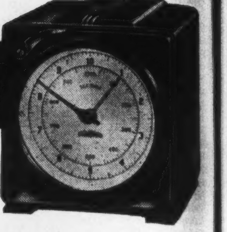
Automatic Temp. Control
Barber Colman
Betts & Betts
Bristol Co.
Cincinnati Time Rec.
Clark Cooper Co.
Cook Electric
Cramer Co., Inc.
Denver Fire Clay
Dimco-Gray Co.
Dorothea Mechanisms
Eagle Signal Corp.
Electronic Controls
Electronic Prod. Co.
Electyme Motor Prods.
Fisher-Pierce Co.
Foxboro Co.
Fuel Watchman
Gaertner Scientific Corp.
General Elec. Co.
Genisco Inc.
Gotham Instrument
Gray Instrument
Hagan Corp.
Hansen Co.
Haydon Co., A. W.
Industrial Timer Corp.
International Register
Jardur Import
Lektra Labs.
Lumenite Electronic
Magnetic Gauge Co.
Manning, Maxwell & Moore
Minneapolis-Honeywell
Montgomery Mfg. Co.
National Time & Signal
Neomatic Inc.
Paragon Electric Co.
Partlow Corp.
Photoswitch, Inc.
Photovolt Corp.
Potter & Brumfield
Potter Instruments Co.
Powers Regulator Co.
Richardson-Allen
Seely Inst. Co., Inc.
Serdex, Inc.
Standard Elec. Time
Stromberg Time Corp.
Struthers Dunn
Tagliabue Div.
Taylor Inst. Cos.
Telechron Inc.
Thompson Clock
Tork Clock Co.
Wallace & Tiernan
Weston Elec. Inst. Corp.
Wilson & Co.

Standard TIMERS



WORLD'S MOST ACCURATE AND RUGGED TIME MEASURING INSTRUMENT. CAN BE MANUALLY OR ELECTRICALLY OPERATED. FURNISHED IN PORTABLE CASES OR FOR PANEL MOUNTING.

T-1

Model	Reads	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

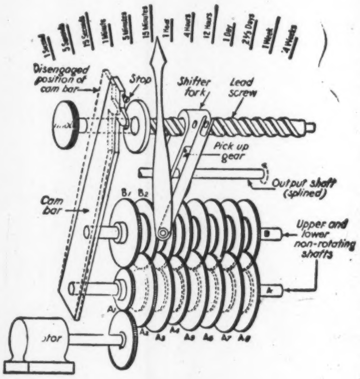
WRITE FOR BULLETIN 153

***also* Standard Chrono-Tachometers •**
Standard Custom-built Laboratory Test and Distribution panels

THE Standard Electric Time Co.

93 Logan Street STANDARD FOUNDED 1884 **Springfield, Mass.**

"M" Unit.



This basic unit operates a line of timers, sequence controls, and chart movers. Two types. (A) "M-M" (minute-to-a-month range) with 10 shaft speeds of 1, 5, 15 **minutes;** 1, 4, 12 **hours;** 1, 2⅓, 7, and 28 **days.** (B) "S-M" (second-to-a-month range). 13 speeds of 1, 5, & 15 **seconds** plus the 10 of the M-M unit. 20 oz. inches torque at every speed. ("M"-units are available as components for your own instruments, apparatus and machine tools. Prices from $65.00 singly to $19.75 each in large numbers.) See detailed write-up on page 92 of the July-August 1951 issue of THE INSTRUMENT MAKER Magazine. Be sure to ask for complete catalog.

OPERATION. Referring to figure. Two series of double gears rotate freely on fixed shafts A & B. Motor power transmitted from A to B series back and forth A_1 to B_1 to A_2 to B_2 etc. Pick-up gear on output shaft is shifted by knob control to desired speed. Pointer shows selection.

For literature, please write to

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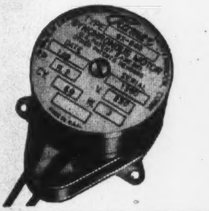
HAWORTH N. J.

Cramer

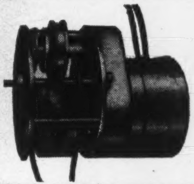
SYNCHRONOUS MOTORS • ELECTRIC TIMERS

A wide range of timing devices, extensively used on electrically-operated commercial and industrial equipment where accurate, dependable timing is essential to insure efficient product performance . . . to add convenience of operation . . . to prevent work spoilage and protect equipment itself. We are frequently called upon to design special equipment to meet specific requirements . . . consult us about your timing problems. Write for complete information.

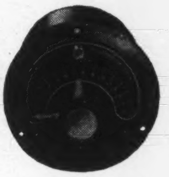
The R.W. CRAMER Co., Inc., Box # 30, Centerbrook, Conn.



TYPE SX SYNCHRONOUS MOTORS — Widely used for instrument and control applications requiring constant speed at a given frequency. Powerful, precision-built. Produce an exceptionally high torque. Available with output speeds from 60 RPM to 1/24 RPH.



TYPES SCS-SCR CLUTCH MOTORS — Designed to meet the needs of many timing, recording, indicating and switching applications requiring reset operation. TYPE SCS — standard clutch type. Type SCR — reversible clutch type.

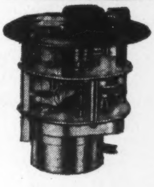


TYPE IE INTERVAL TIMERS — Setting to any desired time opens one load circuit, closes another, starting time cycle. Restores to normal position at end of time interval. Designed to control electrically operated equipment such as mixers, X-ray machines, ovens, plating processes, etc.

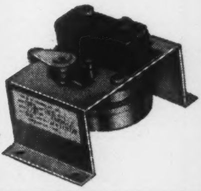
TYPE IG INTERVAL TIMERS — Holds one or two circuits either open or closed for pre-set time and returns them to original position at end of interval. Used for built-in applications in microfilming equipment, battery chargers, therapeutic machines, etc.

TYPE RE RESET TIMERS— Automatically closes one circuit and opens another for a pre-set time when started. Used for control of process work where accuracy of repeat operation is required — on copying machines, laboratory equipment, photo printers, etc.

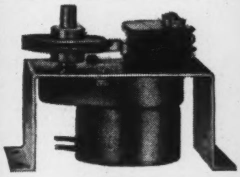
TYPE TE TIME DELAY RELAYS — Provides adjustable time delay between closing of control circuit and subsequent closing or opening of load circuit. Used to control heat treating equipment, shakers, etc.



TYPES TEC - TER TIME DELAY RELAYS — Provide an adjustable time delay between operation of a control circuit and subsequent closing or opening of load circuit. Used in industrial controls for heat treating, lapping, grinding, induction heating, mixing, etc.

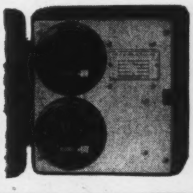


TYPE TF2 TIME DELAY RELAYS — Provide a fixed time delay between closing of control circuit and opening or closing of one or two load circuits. Used to protect high voltage electronic tubes, control of signalling devices, machines or process control, etc.



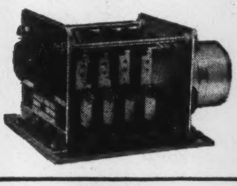
TYPES CF3 - CF6 CYCLE TIMERS — For built-in applications where from one to eight circuits are to be controlled in accordance with a predetermined program — commercial dishwashers, ice-making units, to reverse motors, to operate motors, solenoid valves, etc.

TYPE V PULSE TIMERS — Continuously electrical impulses of a definite set duration at end of successive identical time intervals. Used for control of automatic lubricators, conveyors, pumps, electron tube testing, etc.

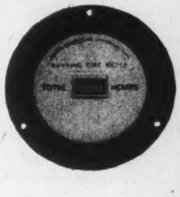


TYPE DU DUPLEX CYCLE TIMERS — Designed to open or close one or two load circuits continuously or to perform one complete cycle and stop. Used to control idle and running time of machines, periodic feeding of chemicals to boilers, etc.

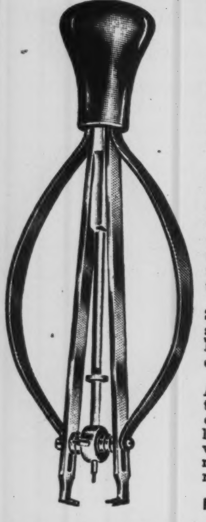
TYPE PE PERCENTAGE TIMER — Designed to control percent of time in which electrical circuit is closed or open out of definite time cycle. Used to regulate input to electrically operated furnaces, ovens or heaters, etc.



TYPE M MULTI-CONTACT TIMERS — Designed to control automatically a number of electrical circuits in predetermined sequence. Used to control a series of machine operations, to reverse motors, valves, signals or combinations in sequence, etc.



TYPE E RUNNING TIME METERS — Designed to cumulatively register total operating or idle time of any circuit, machine or system. Used to record operating time of vacuum tubes, to forecast need for servicing of machines, etc.



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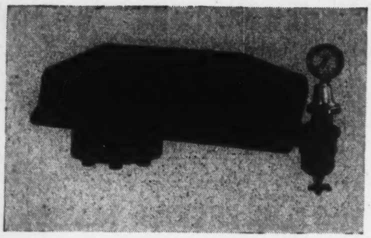

REPUBLIC PNEUMATIC TRANSMITTERS

Republic pneumatic transmitters are devices for converting process variables, such as flow, liquid level, pressure or liquid density, into air pressures which vary proportionally with the process variables.

These air pressures can be used as the measuring impulse for the actuation of an automatic controller or a direct reading recorder.

WRITE FOR DATA BOOK No. 1002

REPUBLIC FLOW METERS CO.
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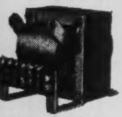
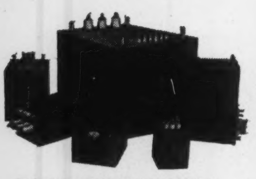
REPUBLIC
INSTRUMENTS • CONTROLS





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Electyme Motor Prods.
General Electric Co.
Industrial Timer
National Time & Signal
Neomatic Inc.
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Photovolt Corp.
Wilson & Co., G. C.

TITRATION APPARATUS, Electrometric
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Burrell Technical Supply
Cambridge Instrument Co.
Central Scientific Co.
Coleman Electric Co.
Fisher Scientific Co.
Gray Instrument
Leeds & Northrup Co.
Pfaltz & Bauer
Precision Scientific
Rubicon Co.
Sargent & Co., E. H.
Thomas Co., Arthur H.
Welch Scientific

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Daco Machine & Tool
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Gaunt Industries
Gustafson Mfg. Co.
Levin & Son
Lovins Engr.
Lufkin Rule Co .
Marshall Co.
Standard Products
Woodruff & Stokes

TOPOGRAPHIC INSTRUMENTS (See Surveying Instruments)

TORQUE GAGES (See Gages, Torque)

TORQUE MEASURING EQUIPMENT
Aero Electronics
Airdraulics Engineering
Emery Co., A. H.
Flight Research Eng.
General Elec. Co.
Hagan Corp.
Hathaway Instrument

(Continued)

Martin-Hubbard Corp.
Saxl Instrument
Skyway Prec. Tool
Sturtevant Co.
Trimount Inst. Co.
Vectron, Inc.

TORSIOGRAPH
Aero Electronics
Baldwin Locomotive
Commercial Research
Consolidated Engg.
Saxl Instrument
Toledo Scale Co.

TORSION METERS
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Airdraulics Engineering
Boulin Inst. Corp.
Chatillon & Sons
Commercial Research
Hathaway Inst. Co.
Riehle Testing Machines
Saxl Instrument
Toledo Scale Co.

TOTALIZERS, Demand
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Esterline-Angus
General Elec. Co.
Landis & Gyr
Leeds & Northrup
Sangamo Electric
Westinghouse Elec.

TOTALIZERS, Electric Energy
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Automatic Elec. Chicago
Bristol Co.
Esterline Angus Co.
General Elec. Co.
Landis & Gyr, Inc.
Leeds & Northrup
Sangamo Electric
Westinghouse Elec.

TOTALIZERS, Fluid Flow
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Askania Regulator Co.
Bailey Meter Co.
Bristol Co.
Brooks Rotameter
Builders-Providence
Engineering Res. & Dev.
Fischer & Porter
Foxboro Co.
General Elec. Co.
Hagan Corp.
Hays Corp.
Henszey Co.
Leeds & Northrup Co.
Leupold & Stevens
Mason-Neilan Regulator
Minneapolis-Honeywell
Mittelman Electronics
National Inst. Labs.
Penn Ind. Inst. Corp.
Republic Flow Meters
Revere Corp.
Simplex Valve & Meter
Smith Meter
Sparling, R. W.
Tagliabue Div.
Taylor Inst. Cos.

TOTALIZERS, Gas Flow
American Meter Co.
Bailey Meter Co.
Bristol Co.
Builders-Providence
Fischer & Porter
Foxboro Co.
Hagan Corp.
Hays Corp.
Minneapolis-Honeywell
Penn Ind. Inst. Corp.
Republic Flow Meters
Simplex Valve & Meter

TOTALIZERS, Running Time
Aero Instrument Co.
Bristol Co.
Cramer Co., Inc.
Elec. Tachometer Corp.
Gorrell & Gorrell
Industrial Timer Corp.
Photoswitch, Inc.
Production Instrument
Standard Elec. Time
Westinghouse Elec. & Mfg.

TRAFFIC SIGNALLING DEVICES (See Signaling Devices, Traffic)

TRAMMELS, Steel Beam
Lufkin Rule Co.

"TRANSDUCERS" (Note: a transducer converts one form of POWER into another. For numerous primary measuring elements incorrectly called "transducers," see the correct headings under the measurables, the instruments, etc.)

TRANSDUCERS, Ultrasonic
Branson Instruments, Inc.
Brush Development
Electro-Mec Lab.
Electro Products Labs.
Gen. Precision Lab.
Gulton Mfg. Co.
Laboratory for Electronics
Massa Labs.
Monsell, J. R.
Pacific Div., Bendix
Reed Research
Rutishauser Corp.
Sperry Products

TRANSFORMERS, Adjustable
Airdesign, Inc.
Allied Control Co.
American Transformer
Freed Transformer
General Electric

(Continued)

General Radio Co.
Gramer Transformer
Halldorson Co.
Hevi Duty Elec.
Lindberg Engineering
Miller Transformer
Raytheon Mfg. Co.
Sorensen & Co.
Superior Electric Co.
Thordarson Elec. Mfg. Co.
Trenton Transformer
United Transformer

TRANSFORMERS, Constant Voltage
Airdesign, Inc.
Better Coils Inc.
Boonton Radio Corp.
Chicago Electronic
Cole Instrument
General Controls
General Electric Co.
Hevi-Duty Elec.
Magnetic Amplifiers
Miller Transformer
Perfex Corp.
Sola Electric Co.
Sorensen & Co.
Standard Transformer
Superior Electric Co.
Thordarson Elec. Mfg.
United Transformer
Westinghouse Elec.

TRANSFORMERS, Experimenter's Variable Voltage
Airdesign, Inc.
Allied Control Co.
American Transformer
Better Coils Inc.
Chicago Electronic
DoAll Co.
Dongan Electric Co.
Freed Transformers
General Controls
General Radio Co.
Gramer Transformer
Halldorson Co.
Hevi-Duty Elec.
Merit Transformer
Miller Transformer
Raytheon Mfg.
Sorensen & Co.
Standard Transformer
Sorvall, Ivan
Southwestern Ind. Elec.
Superior Electric Co.
Thordarson Elec. Mfg.
Trenton Transformer
United Transformer
Walker-Jamieson, Inc.

TRANSFORMERS, Impedance
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Freed Transformer Co.
General Electric Co.
Gramer Transformer
Halldorson Co.
Merit Transformer
Miller Transformer
Raytheon Mfg. Co.
Southwestern Ind. Elec.
Sperry Gyroscope Co.
Standard Transformer
Sorenson & Co.

TRANSFORMERS, Instrument
Aeromarine Inst. Co.
Airdesign, Inc.
Allied Control Co.
Allis-Chalmers
Amplifier Co.
Annis Co.
Assembly Products
Associated Research
Audio Development
Better Coils, Inc.
Burlington Inst. Co.
Chicago Electronic
Chicago Transformer
Cole Instrument
Columbia Elec. Mfg.
Control Corp.
Eastern Specialty Co.
Eclipse-Pioneer Div.
Elec. Facilities, Inc.
Esterline Angus Co.
Federal Telegraph Co.
Freed Transformer
Friez Instrument
General Controls
General Elec. Co.
Gramer Transformer
Hagan Corp.
Halldorson Co.
Hickok Elec. Inst. Co.
Industrial Insts. Inc.
Kollsman Inst. Div.
Manning, Maxwell, Moore
Merit Transformer
Miller Transformer
New York Transformer
Phen-Trols, Inc.
Roller-Smith Co.
Sangamo Electric Co.
Servomechanisms, Inc.
Simpson Electric Co.
Sorensen & Co.
Southwestern Ind. Elec.
Sperry Gyroscope Co.
Standard Science Sup.
Standard Transformer
Sticht Co.
Superior Electric Co.
Thordarson Elec. Co.
Trenton Transformer
Utah Radio Produs.
United Transformer Corp.
Westinghouse Elec.
Weston Elec. Inst. Corp.

TRANSFORMERS, Insulation Testing
Airdesign, Inc.
American Transformer
Amplifier Co.
Associated Research
Better Coils, Inc.
Campbell Electric

(Continued)

Chicago Electronic
Cole Instrument
Freed Transformer
General Controls
General Elec. Co.
Gramer Transformer
Lenkurt Electric Co.
Miller Transformer
Raytheon Mfg. Co.
Sherron Metallic
Superior Electric Co.
Thordarson Elec. Mfg.
Trenton Transformer
United Transformer

TRANSFORMERS, Laboratory

Airdesign, Inc.
Allied Control Co.
American Inst. Co.
American Transformer
Amplifier Co.
Audio Development
Better Coils, Inc.
Burrell Tech. Supply
Central Scientific Co.
Chicago Electronic
Chicago Transformer
Clough-Brengle Co.
Daven Co.
Eastern Specialty Co.
Elec. Facilities, Inc.
Electro-Tech Equip. Co.
Esterline-Angus
Ferranti Electric
Freed Transformer
General Elec. Co.
General Radio Co.
Gorrell & Gorrell
Gramer Transformer
Halldorson Co.
Harvey-Well Electronics
Hevi Duty Elec.
Hickok Elect. Inst.
Laboratory Equip. Corp.
Lenkurt Electric Co.
Merit Transformer
Miller Transformer
New York Transformer
Raytheon Mfg. Co.
Scientific Glass App.
Sola Electric Co.
Sorenson & Co.
Southwestern Ind. Elec.
Standard Elec. Prod.
Standard Transformer
Superior Electric Co.
Thordarson Elec. Co.
Trenton Transformer
United Transformer Corp.
Westinghouse Elec.
Weston Elec. Inst. Corp.

TRANSFORMERS, Microwave

Better Coils, Inc.
Freed Transformer
General Electric Co.
Raytheon Mfg. Co.
Sperry Gyroscope Co.
Sorensen & Co.

TRANSFORMERS, Phasing

Airdesign, Inc.
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Eastern Specialty Co.
Esterline Angus
Freed Transformer
General Elec. Co.
Gramer Transformer
Merit Transformer
New York Transformer
Raytheon Mfg. Co.
States Co.
Thordarson Mfg. Co.
United Transformer Corp.
Westinghouse Elec.

TRANSFORMERS, Power

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Allis-Chalmers
American Transformer
Amplifier Co.
Audio Development
Better Coils, Inc.
Chicago Electronic
Chicago Transformer
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Federal Telegraph Co.
Ferranti Electric
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General Controls
General Elec. Co.
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Lindberg Engineering
Merit Transformer
Miller Transformer
New York Transformer
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Sola Electric Co.
Sorensen & Co.
Standard Transformer
Superior Electric
Thermador Elec.
Thordarson Elec. Mfg.
Trenton Transformer
United Transformer
Weston Elec. Inst.

TRANSFORMERS, Split Core

Airdesign, Inc.
Allied Radio Corp.
Annis Co.
Assembly Products
Better Coils, Inc.
Chicago Electronic
Cole Instrument
Elec. Facilities, Inc.
Esterline-Angus Co.
Freed Transformer
General Elec. Co.

(Continued)

Gramer Transformer
H-D Elec. Co.
Islip Radio Mfg.
Roller-Smith Co.
Rubicon Co.
Sangamo Electric Co.
Sorensen & Co.
Thordarson Elec. Co.
United Transformer Corp.
Westinghouse Elec.

TRANSFORMERS, Variable Voltage Testing

Airdesign, Inc.
Allied Control Co.
American Transformer
Better Coils, Inc.
Chicago Electronic
Federal Telegraph Co.
Freed Transformer
General Electric Co.
General Radio Co.
Gramer Transformer
Merit Transformer
Miller Transformer
Phen-Trols, Inc.
Raytheon Mfg. Co.
Sorensen & Co.
Standard Transformer
States Company
Superior Electric Co.
Thordarson Elec. Mfg.
Trenton Transformer
United Transformer

TRANSFORMERS, Voltage Regulating

Airdesign, Inc.
Allied Radio Corp.
Allis-Chalmers
American Transformer
Amplifier Co.
Boonton Radio Corp.
Chicago Transformer
Cole Instrument
Davis & Co., Inc., Dean
General Elec. Co.
Gramer Transformer
Halldorson Co.
Hevi Duty Electric
Magnetic Amplifiers
Miller Transformer
Sola Electric Co.
Sorensen & Co.
Standard Transformer
Superior Electric
Thordarson Elec. Mfg.
Trenton Transformer
United Transformer Corp.

TRANSITS, Engineer's (See Surveying Instruments)

TRANSITS, Pocket

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Keuffel & Esser Co.
Leupold & Stevens
Mico Instrument Co.
Suverkrop Instruments
United States Blue Print
Warren Knight Co.
White Co., Inc.

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TRUCK-TIME RECORDERS

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U. S. Taximeter

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TUBES (See Gas & Vapor Discharge Tubes)

TUBES, Cathode Ray (See Oscillographs, Cathode Ray)

TUBES, Nessler (See Nessler Tubes)

TUBES, Oil Centrifuge (See Oil Centrifuge Tubes)

TUBES, Photoelectric

Continental Electric Co.
General Elec. Co.
General Scientific Co.
Instrument Dev. Labs.
Precise Measurements
RCA Div.
Vacutron, Inc.
Walker-Jamieson, Inc.

TUBES, Pitot (See Flowmeters, Pitot Tube)

TUBES, Polariscope

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TUBES, Pyrometer

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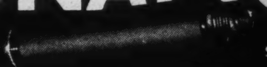

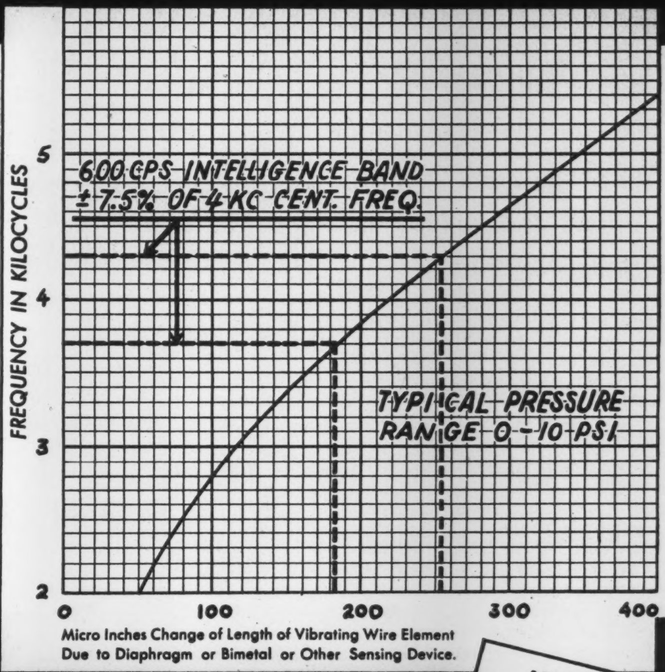
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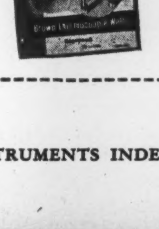

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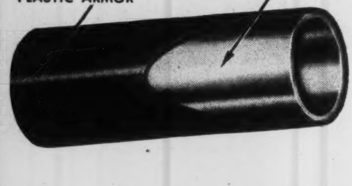

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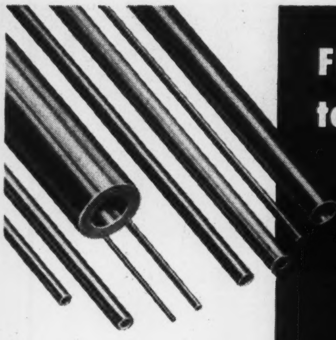

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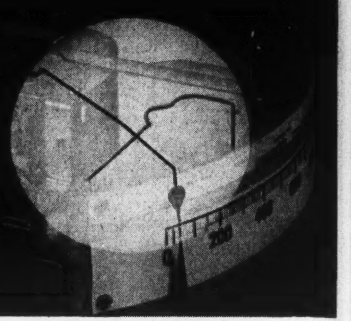

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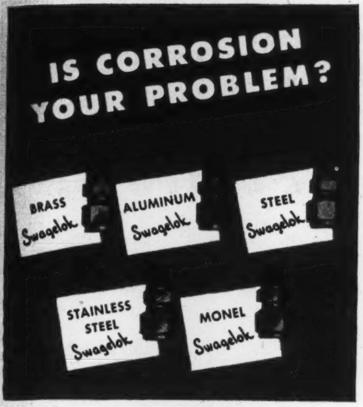

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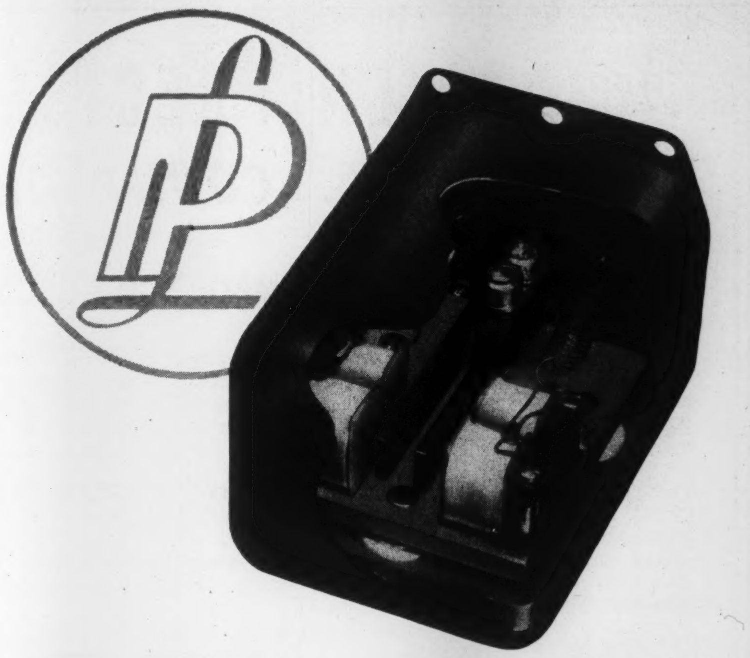

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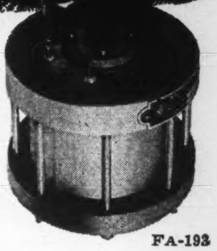
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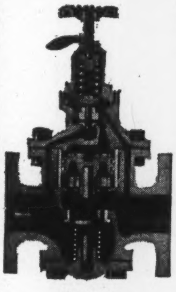
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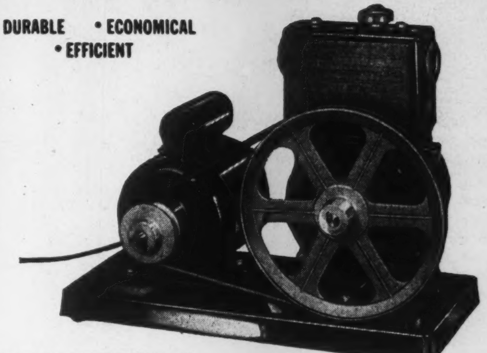

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FLEX VALVE

Flexible Valve Corporation

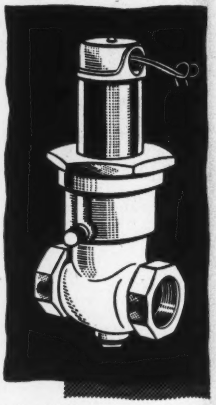
336 COMMERCIAL AVE. • PALISADES PARK, N. J.

ATKOMATIC

EXTRA RUGGED

ELECTRICALLY OPERATED

VALVES



In thousands of installations . . . in this and other countries . . . Atkomatic Valves continue to give years of dependable, trouble-free service. That's because they are *extra rugged*—built to take *more* than you will demand. Compact and simple, they are made for pressures of one to 3,000 pounds. In your plant or on your product, you can count on ATKOMATIC. Send us your individual problem . . . maybe we've already solved it!

ATKOMATIC VALVE COMPANY, INC.

545 W. ABBOTT STREET, INDIANAPOLIS, INDIANA

Send For Literature

DIAPHRAGM OPERATED CONTROL VALVES in CORROSION RESISTING ALLOYS

PROMPT DELIVERIES, because they're machined from available barstocks . . . NO CASTING DELAYS!

Your requirements for pneumatic control valves in many unusual alloys can be met promptly with CONOMOTOR Type AB-10 Barstock body valves. Available in ½", ¾" and 1" nominal pipe sizes with screwed connections. Standard 600 pound pressure rating can be furnished as semi-standard for pressures to 3,000 psi (cold).

REQUEST BULLETIN AB-10-2-1

STANDARD MATERIALS AVAILABLE

Hastelloy
Durimet
Monel
Everdur
Nickel

And most other machineable metals

Cono-Controls

CONOFLOW CORPORATION

[illegible]

Phillips Petroleum
Preferred Utilities
R-S Prod. Corp.
Schade Valve Mfg. Co.
Seely Inst. Co., Inc.
Sinclair-Collins Valve
Skaneateles Mfg. Co.
Smith Meter
Tagliabue Div.
Valvair Corp.
Vapor Recovery Systems
Wheelco Instruments

VALVES, Automatic Solenoid (See Valves, Solenoid)

VALVES, Balanced

Acme Scientific
American Meter Co.
Atlas Valve Co.
Bailey Meter Co.
Baldwin Locomotive
Barber Colman
Boylston Co.
Bristol Co.
Cash Co.
Clark Cooper Co.
Climax Div.
Conoflow Corp.
Davis Reg. Co.
Defender Inst. & Reg.
Dennison Engineering
Fischer & Porter
Fisher Governor Co.
Ford Reg. Valve Co.
Foster Engg. Co.
Foxboro Co.
General Controls Co.
Hammel-Dahl Co.
Jenkins Bros.
Keckley Mfg. Co.
Kieley & Mueller
Klipfel Mfg. Co.
Leslie Co.
Mason-Neilan Regulator
McAlear Mfg.
Minneapolis-Honeywell
Natural Gas Equipment
North Amer. Mfg. Co.
Northern Equip. Co.
OPW Corp.
Powers Regulator Co.
Republic Flow Meters
Reynolds Gas Regulator
Schade Valve Mfg. Co.
Seely Inst. Co., Inc.
Sinclair Collins Valve
Spence Engineering Co.
Swartwout Co.
Tagliabue Div.
Trerice Co.
Watts Regulator Co.
Wood, Harry W.

(Continued)

VALVES, Constant Pressure

Assoc. Valve & Engrg.
Atlas Valve
Bailey Meter Co.
Bastian-Blessing Co.
Brooke Engineering
Cash Co.
Clark Cooper Co.
Climax Div.
Davis Reg. Co.
Dennison Engineering
Fisher Governor Co.
Foster Engg. Co.
General Controls
Grove Regulator
Hammel-Dahl Co.
Henry Valve Co.
Hoke, Inc.
Jenkins Bros.
Keckley Mfg. Co.
Kieley & Mueller
Klipfel Mfg. Co.
Leslie Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg.
Mercon Regulator
Northern Equipment
Powers Regulator Co.
Reynolds Gas Regulator
R-S Prod. Corp.
Schade Valve Mfg. Co.
Seely Inst. Co.
Sinclair-Collins Valve
Spence Engineering Co.
Swartwout Co.
Tagliabue Div.
Taylor Inst. Co.
Vapor Recovery Systems
Vaughn-G. E. Witt Co.
Watts Regulator Co.

VALVES, Diaphragm

Adel Precision Products
Annin Co.
Askania Regulator Co.
Assoc. Valve & Engrg.
Atlas Valve Co.
Automatic Temp. Control
Bailey Meter Co.
Baldwin-Lima-Hamilton
Bastian-Blessing Co.
Boylston Co.
Bristol Co.
Cash Co.
Climax Div.
Conoflow Corp.
Continental Equip. Co.
Cook Electric
Davis Reg. Co.
Defender Inst. & Reg.
Eclipse-Pioneer Div.
Emmett Machine
Farris Engineering
Fischer & Porter
Fisher Governor
Flexible Valve Corp.
Foster Engg. Co.
Foxboro Co.
General Controls Co.
Gotham Inst. Co.
Hagan Corp.
Hammel-Dahl Co.
Henry Valve Co.
Hills-McCanna
Hoke, Inc.
Industrial Filter
Johnson Service Co.
Keckley Mfg. Co.
Kieley & Mueller
Klipfel Mfg. Co.
Laboratory Equipment
Ledeen Mfg.
Leslie Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg.
Mead Specialties Co.
Minneapolis-Honeywell
Natural Gas Equipment
North Amer. Mfg. Co.
Partlow Corp.
Paul Valve Co.
Powers Regulator Co.
Refrigerating Spec. Co.
Republic Flow Meters
Research Control Insts.
Reynolds Gas Regulator
Rockwell Mfg.
R-S Products Corp.
Schade Valve Mfg. Co.
Scientific Instrument Co.
Seely Inst. Co., Inc.
Sinclair Collins Valve
Spence Engineering Co.
Swartwout Co.
Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
Valvair Corp.
Vaughn-G. E. Witt
Watts Regulator
White-Rodgers Electric

VALVES, Electrically Operated

Adel Precision Prods.
Assoc. Valve & Engrg.
Atlas Valve Co.
Automatic Products Co.
Automatic Temp. Control
Baldwin Locomotive
Barber-Colman
Beck Co.
Bristol Co.
Brooke Engineering
Clark Cooper Co.
Cutler-Hammer, Inc.

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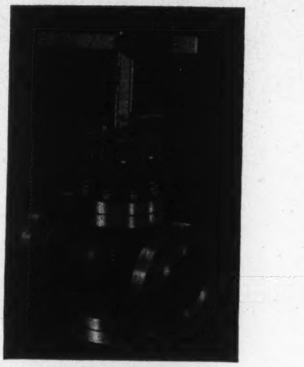


REPUBLIC REGULATING VALVES

All Republic valves are engineered to the specific job on which they are used. Cylinder operated valves are available in sizes from 3 in. to 24 in. Hand operated valves in sizes from 1 in. to 8 in. Lever operated valves in sizes up to 16 inch.

Republic valves are built in all pressure standards — both flanged and welded ends. Streamlined flow through parts virtually eliminates erosion.

WRITE FOR DATA BOOK No. S-40

REPUBLIC FLOW METERS CO.
2240 Diversey Pkwy. Chicago 47, Ill.

REPUBLIC INSTRUMENTS • CONTROLS

Davis Reg. Co.
Defender Inst. & Reg.
Denison Engineering
Distillation Products
Electric Valve Mfg.
Flexible Valve Corp.
Foster Engg. Co.
Foxboro Co.
Frick Co.
Friez Instrument
General Controls Co.
General Electric Co.
Henry Valve Co.
Hills-McCanna
Jenkins Bros.
Keckley Mfg. Co.
Kieley & Mueller
Klipfel Mfg. Co.
Lear, Inc.
Leslie Co.
Magnatrol Valve Corp.
Manning, Maxwell & Moore
Marsh Corp., Jas. P.
Mason-Neilan Regulator
Minneapolis-Honeywell
North Amer. Mfg. Co.
Northern Equipment Co.
Paul Valve Co.
Penn Electric Switch
Perfex Corp.
Philadelphia Gear Works
Preferred Utilities
R-S Prod. Corp.
Schade Valve Mfg. Co.
Seely Inst. Co., Inc.
Shallcross Controls
Shallcross Mfg. Co.
Sinclair-Collins Valve
Spence Engineering Co.
Supreme Elec. Prods.
Tagliabue Div.
Wheelco Instruments
White-Rodgers Elec. Co.
Yellow Springs Inst. Co.

VALVES, Hydraulically Operated

Acme Industrial
Adel Precision
Annin Co.
Arca Regulators, Inc.
Askania Regulator
Assoc. Valve & Engrg.
Atlas Valve Co.
Auto. Temp. Control
Bailey Meter
Baldwin Locomotive
Barber Colman Co.
Cash Co.
Clark Cooper Co.
Conoflow Corp.
Continental Equip. Co.
Controls, Inc.
Defender Inst. & Reg.
Denison Engineering
Eclipse-Pioneer Div.
Farris Engineering
Fisher Governor
Flexible Valve Corp.
Ford Reg. Valve
Foster Engg. Co.
General Controls
General Electric Co.
General Regulator Corp.
Hagan Corp.
Hammel-Dahl Co.
Hays Corp.
Hills-McCanna
Hydraulic Controls, Inc.
Jenkins Bros.
Johnson Service Co.
Keckley Mfg. Co.
Kieley & Mueller
Ledeen Mfg.
Leslie Co.
Leupold & Stevens
Mason-Neilan Regulator
McAlear Mfg. Div.
North Amer. Mfg. Co.
Paul Valve Co.
Perfex Corp.
Philadelphia Gear Works
Powers Regulator Co.
Republic Flow Meter
Rockwell Mfg.
R-S Prod. Corp.
Schade Valve Mfg. Co.
Seely Inst. Co.
Shallcross Controls
Sinclair-Collins Valve
Shand & Jurs Co.
Spence Engineering
Sterling Eng. Co.
Sundstrand Machine Tool
Valvair Corp.
Vectron, Inc.
Waterman Eng. Co.

VALVES, Lubricated Plug

Acme Industrial
Clark Cooper Co.
Imperial Brass Mfg.
Industrial Filter
Parker Appliance
Rockwell Mfg.

VALVES, Motor Operated (See Valves, Diaphragm; Valves, Electrically-operated; Valves, Hydraulically-operated; Valves, Solenoid)

VALVES, Pressure Relief, Reducing, etc.

Acme Industrial
Adel Precision Prods.
American Meter Co.
Ashton Valve Co.
Askania Regulator Co.
Assoc. Valve & Engrg.

(Continued)

YOUR SAFETY VALVES CAN BE

BOOBY TRAPS

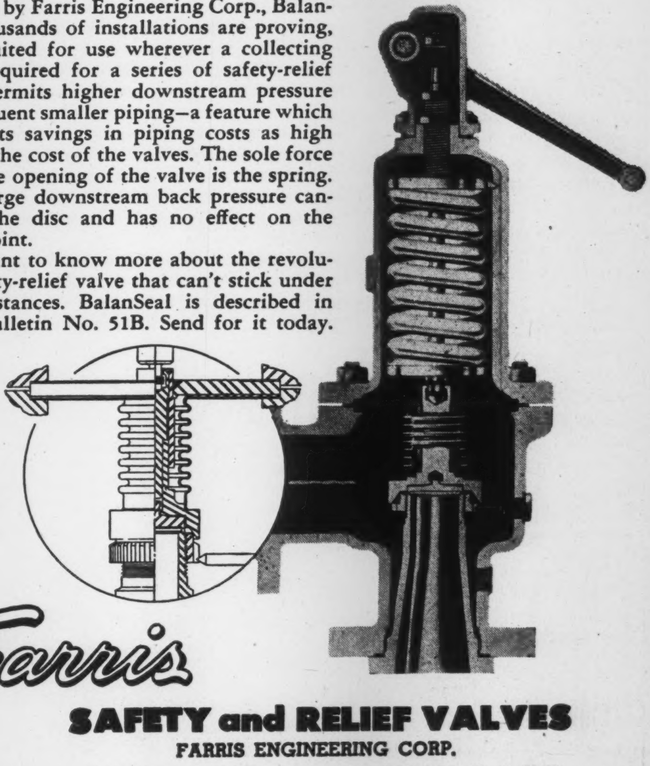
A safety valve that sticks is about as safe as a time bomb

Only BalanSeal© and FarriSeal© provide the positive protection at all times and under all operation conditions that makes them reliably safe.

Unique in design and principle, the BalanSeal Safety-Relief Valve has a protective bellows which is proportioned to eliminate any unbalanced downstream forces on the valve disc—which is perfectly balanced on its seat at the set pressure. Like its companion, the FarriSeal Valve, the guide, stem and spring are completely isolated from the lading fluid for perfect protection.

Pioneered by Farris Engineering Corp., BalanSeal, as thousands of installations are proving, is ideally suited for use wherever a collecting system is required for a series of safety-relief valves. It permits higher downstream pressure with consequent smaller piping—a feature which often permits savings in piping costs as high as 15 times the cost of the valves. The sole force opposing the opening of the valve is the spring. Static or surge downstream back pressure cannot affect the disc and has no effect on the relieving point.

You'll want to know more about the revolutionary safety-relief valve that can't stick under any circumstances. BalanSeal is described in detail in Bulletin No. 51B. Send for it today.



Patented and Patents Pending

Farris

SAFETY and RELIEF VALVES

FARRIS ENGINEERING CORP.
536 Commercial Avenue Palisades Park, N. J.

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"Ours Measure Where Others Fail"

Millivac vacuum tube meters are unusual measuring instruments which cover functions and ranges beyond those of ordinary vacuum tube meters.

MV-11A DC micro-micro-ammeter, 10 uuA to 10 A DC

MV-15A DC microvolt meter, 0.5 uV to 1 V

MV-17B High impedance DC millivolt meter, 50 uV to 1,000 V

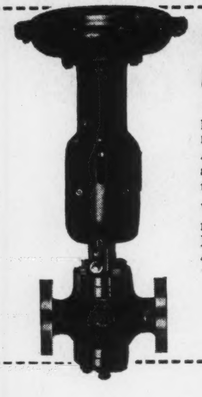
MV-18B RF Millivolt meter, 1mV to 1,000 V, 1 MC to 2,500 MC

MV-73B Multi-meter, 10 mV to 1,000 V, AC, DC, RF, also 0.1 uA to 10 A, AC, DC, and 6 ohm ranges.

Millivac meters feature highest sensitivity in conjunction with stability and minimum circuit loading. Our RF probes have input capacities down to 1.25 MMF. All instruments are available with change-over switch for operation of external meters and recorders. In addition, a complete line of Millivac electronic recorders features the well-known Sanborn heat-writing unit in combination with Millivac amplifiers.

Our Engineering Department will gladly assist you in solving unusual measuring problems. Write for our bulletins and free technical advice.

Millivac Instrument Corporation
Box 997, Schenectady, N. Y.



HONEYWELL DIAPHRAGM MOTOR CONTROL VALVES

• Compare the Honeywell Series "700" with any other wide band proportional control valve. Your comparison will prove it can't be matched for sensitivity, dependability and low maintenance. Available in a wide range of styles and sizes. The Honeywell line also includes liquid level controllers and diaphragm motor operators of both the spring and springless types.

Write for Catalog 700-2 for detailed information on diaphragm motor valves and Bulletin 750 for Control Valve Sizing Data. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4579 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

Valve Products

Atlas Valve Co.
Autoclave Engineers
Bailey Meter Co.
Bastian-Blessing Co.
Bristol Co.
Brown & Sharpe
Cash Co.
Clark Cooper Co.
Climax Div.
Conoflow Corp.
Crosby Steam Gage Co.
Davis Reg. Co.
Eclipse-Pioneer Div.
Farris Engineering
Fisher Governor Co.
Ford Reg. Valve
Foster Engg. Co.
Foxboro Co.
Frick Co.
Fulton-Sylphon
General Controls
Gotham Inst. Co.
Grove Regulator
Hagan Corp.
Hammel-Dahl Co.
Henry Valve Co.
Hoke, Inc.
Instrument Repair & Mfg.
Johnston & Jennings Co.
Keckley Mfg. Co.
Kenyon Instrument Co.
Kieley & Mueller
Klipfel Mfg. Co.
Lammert & Mann Co.
Lear, Inc.
Leslie Co.
Lonergan Co.
Manning, Maxwell & Moore
Marsh Corp., Jas. P.
Mason-Neilan Regulator
McAlear Mfg.
Mead Specialties
Mercon Regulator
Minneapolis-Honeywell
Natural Gas Equipment
Northern Equipment
Parker Appliance
Powers Regulator Co.
Preferred Utilities
Republic Flow Meters
R-S Products Corp.
Ruska Inst. Corp.
Schade Valve Mfg. Co.
Seely Inst. Co., Inc.
Shand & Jurs Co.
Spence Engineering Co.
Swartwout Co.
Tagliabue Div.
Taylor Instr. Cos.
Trerice Co.
Vapor Recovery Systems
Victor Equipment Co.
Watts Regulator Co.

VALVES, Proportional Air-Gas

American Meter Co.
Askania Regulator Co.
Automatic Temp. Control
Barber-Colman
Bristol Co.
Cash Co.
Cutler-Hammer, Inc.
Fisher Governor Co.
General Controls
Hagan Corp.
Hammel-Dahl Co.
Keckley Mfg. Co.
Lammert & Mann Co.
Mason-Neilan Regulator
North American Mfg.
Parker Appliance Co.
R-S Prod. Corp.
Tagliabue Div.
Trerice Co.

VALVES, Regulating

Am. Gas Furnace Co.
American Meter Co.
Arca Regulators, Inc.
Askania Regulator Co.
Assoc. Valve & Engrg.
Atlas Valve Co.
Autoclave Engineers
Automatic Temp. Control
Bailey Meter Co.
Barber Colman
Bastian-Blessing Co.
Boylston Co.
Bristol Co.
Brooke Engineering

(Continued)

Cash Co.
Clarke Cooper Co.
Climax Div.
Conoflow Corp.
Cook Electric
Davis Reg. Co.
Defender Inst. & Reg.
Electronic Corp.
Erickson Specialty
Farris Stacon
Fischer & Porter
Fisher Governor Co.
Flexible Valve Corp.
Ford Reg. Valve Co.
Foster Engg. Co.
Foxboro Co.
Friez Instrument Div.
Fulton Sylphon Div.
General Controls Co.
Grove Regulator
Hagan Corp.
Hammel-Dahl Co.
Hannifin Mfg. Co.
Hoke, Inc.
Jenkins Bros.
Keckley Mfg. Co.
Kieley & Mueller
Klipfel Mfg. Co.
Lammert & Mann Co.
Leslie Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg. Div.
Mead Specialties Co.
Mercon Regulator
Minneapolis-Honeywell
Natural Gas Equipment
North Amer. Mfg. Co.
Northern Equipment Co.
Partlow Co.
Parr Inst. Co.
Podbielniak, Inc.
Powers Regulator Co.
Preferred Utilities
Republic Flow Meters
Robertshaw Thermostat
R-S Prod. Corp.
Rugka Inst. Corp.
Schade Valve Mfg. Co.
Seely Inst. Co., Inc.
Shallcross Controls
Spence Engineering Co.
Swartwout Co.
Tagliabue Div.
Taylor Inst. Cos.
Trerice Co.
Vapor Recovery Systems
Vaughn G. E. Witt
Waterman Engineering
Watts Regulator Co.
Wheelco Instruments

VALVES, Safety Fuel Shutoff

American Meter Co.
Annin Co
Askania Regulator Co.
Atlas Valve Co.
Automatic Products Co.
Automatic Switch Co.
Bastian-Blessing
Bristol Co.
Cash Co.
Clark Cooper Co.
Climax Div.
Continental Equip. Co.
Davis Reg. Co.
Eclipse Fuel Engg. Co.
Farris Engineering
Fisher Governor
Friez Instrument Div.
Fulton Sylphon Div.
General Combustion Corp.
General Controls Co.
Grove Regulator
Hammel-Dahl Co.
Henry Valve Co.
Keckley Mfg. Co.
Kieley & Mueller
Leslie Co.
Lonergan Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
Milwaukee Gas Specialty
Minneapolis-Honeywell
Natural Gas Equipment
North Amer. Mfg. Co.
OPW Corp.
Partlow Corp.
Penn Electric Switch

(Continued)

Phillips Petroleum
Preferred Utilities Mfg.
R-S Products
Schade Valve Mfg. Co.
Seely Inst. Co., Inc.
Spence Engineering Co.
Tagliabue Div.
Vapor Recovery Systems
Viking Instrument Co.
Wheelco Instruments

VALVES, Solenoid

Adel Precision Prods.
Annin Co.
Assoc. Valve & Engrg.
Atlas Valve Co.
Automatic Products Co.
Automatic Temp. Control
Baldwin-Lima-Hamilton
Barber-Colman Co.
Clark Cooper Co.
Continental Equip. Co.
Cook Electric
Cutler-Hammer, Inc.
Davis Reg. Co.
Denison Engineering
Distillation Products
Emmett Machine
Erickson Specialty
Foxboro Co.
Frick Co.
Friez Instrument Div.
General Controls Co.
General Electric Co.
Gleason-Avery, Inc.
Gordon Co., Claud S.
Grove Regulator
Guardian Elec. Mfg.
Hannifin Mfg. Co.
Hays Corp.
Henry Valve Co.
Hills-McCanna
Instrument Dev. Labs.
Kieley & Mueller
Leslie Co.
Magnatrol Valve Corp.
Marsh Corp., Jas. P.
Minneapolis-Honeywell
Northern Equip. Co.
Partlow Corp.
Paul Valve Co.
Perfex Corp.
Preferred Utilities
R-S Prod. Corp.
Sampsel Time Control
Schade Valve Mfg. Co.
Schwien Engr.
Seely Inst. Co., Inc.
Shallcross Controls
Sinclair Collins Valve
Skaneateles Mfg. Co.
Spencer Engineering Co.
Sterling Eng. Co.
Sundstrand Machine Tool
Tagliabue Div.
Taylor Inst. Cos.
Valvair Corp.
Wheelco Instruments
White Rodgers Elec.
Yellow Springs Instrument

VALVES, Thermostat (See Thermostats)

VAR METERS (See Volt-ampere Meters, Reactive)

VEHICLE TRAVEL RECORDERS

Commercial Research
Cramer & Co.
Elec. Tachometer Corp.
Knopf Instrument
Service Recorder Co.
Speedometer Electric
U. S. Taximeter

VENTURI METERS (See Flowmeters, Venturi)

VENTURI TUBES (See Flowmeters, Venturi)

VIBRATION ISOLATORS (See Mountings)

VIBRATION PICKUPS

Amperite Co.
Baldwin-Lima-Hamilton
Brush Development
Calidyne Co.
Commercial Research
Consolidated Engg.
Crystal Research Labs.
Boekel & Co.

(Continued)

Electro Prod. Labs.
Engineering Res. & Dev.
Flader Inc., Fredric
General Electric
General Radio Co.
Geophysical Inst. Co.
Haines Designed Prod.
Hathaway Inst. Co.
Heiland Research
Lion Mfg., Inc.
Massa Laboratories
M B Mfg. Co.
Minnesota Electronics
Phillips Petroleum
Schaevitz Engineering
Scott Inc., Hermon
Sperry Gyroscope Co.
Statham Labs.
Van Dyke Instruments
Westinghouse Elec.
Wiancko Engineering

VIBOGRAPHS

Baldwin-Lima-Hamilton
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Commercial Research
Heiland Research
Impact Register Co.
RCA Div.
Ruska & Co.
Vibration Specialty
Westinghouse Elec.

VIBROMETERS

Aircraft Electronics
American Inst. Co.
Associated Research
Consolidated Engg.
Electrocon Corp.
General Electric
General Radio Co.
Haines Designed Prod.
Hathaway Instrument
Heiland Research
Martin-Hubbard Corp.
Massa Laboratories
M. B. Mfg. Co.
Potter Co.
Sticht Co.
Van Dyke Instruments
Vibration Specialty
Walkirt Co.
Westinghouse Elec.

VIBROSCOPES

Aircraft Electronics
Amperite Corp.
Brush Development
Century Geophysical
Coleman Instrument
Commercial Engg. Labs.
Electro Products Labs.
General Elec. Co.
Heiland Research Corp.
Humboldt Mfg. Co.
Massa Laboratories
M. B. Mfg. Co.
Varo Mfg. Co.

VICAT NEEDLES (See Needles Vicat)

VISCOSIMETER BATHS, Constant-temperature

American Inst. Co.
Brabender Corp.
Braun Corp.
Central Scientific Co.
Coleman Inst. & Reg.
Eitzen Co.
Electric Hotpack Co.
Fish-Schurman Corp.
Fisher Scientific Co.
Humboldt Mfg. Co.
Koehler Instrument
Modern Electrical Lab.
Precision Scientific Co.
Process & Instruments
Ruska Instrument
Sargent & Co., E. H.
Scientific Glass App.
Tenney Engr.
Thomas Co., Arthur H.
Thwing-Albert

VISCOSIMETER, Brookfield

Brookfield Eng. Labs.

VISCOSIMETERS, Engler

American Inst. Co.

(Continued)

Central Scientific Co.
Hiergesell & Sons
Humboldt Mfg. Co.
Kimble Glass
Precision Scientific Co.
Ruehfel Co.

VISCOSIMETERS, Fenske
American Inst. Co.
Fisher Scientific Co.
Humboldt Mfg. Co.
Kimble Glass
Phoenix Prec. Inst.
Precision Scientific

VISCOSIMETERS, Ford (For Paint)
Central Scientific Co.
Humboldt Mfg. Co.
Koehler Instrument Co.
Scientific Inst. Co.

VISCOSIMETERS, Hoeppler
Central Scientific Co.
Fish-Schurman Co.
Phoenix Prec. Inst.
Precision Scientific
Sargent & Co.

VISCOSIMETERS, Kinematic
American Inst. Co.
Braun Corp.
Fischer & Porter
Fisher Scientific Co.
Hiergesell & Sons
Koehler Instrument
Precision Scientific Co.

VISCOSIMETERS, MacMichael
Fisher Scientific Co.

VISCOSIMETER (For Plastic Flow Fluids)
Doelcam Corp.
Norcross Corp.
Southwestern Ind. Elec.

VISCOSIMETERS, Recording
Brabender Corp.
Brookfield Engg. Labs.
Coleman Inst. & Mfg.
Doelcam Corp.
Fischer & Porter
Hayes Scientific App.
Norcross Corp.
Precision Scientific

VISCOSIMETERS, Redwood
American Inst. Co.
Hiergesell & Sons
Ruehfel Co.

VISCOSIMETERS, Saybolt
American Inst. Co.
Boekel & Co.
Central Scientific Co.
Corning Glass Works
Eitzen Co.
Fisher Scientific
Hiergesell & Sons
Humboldt Mfg. Co.
Kimble Glass Co.
Monarch Mfg. Wks.
Precision Scientific Co.
Ruehfel Co.
Zuhr, Inc., Henry

VISCOSIMETERS, Scott
Boekel & Co.
Central Scientific Co.
Hiergesell & Sons
Precision Scientific Co.
Ruehfel Co.
Sargent & Co.
Scott Testers

VISCOSIMETERS, Stormer
Aloe Co., A. S.
Central Scientific Co.
Hiergesell & ons
Industro-Scientific Co.
Thomas Co., Arthur H.

VISCOSIMETERS, Ubbelhode
American Inst. Co.
Boekel & Co.
Central Scientific Co.
Fish-Schurman Co.
Fisher Scientific
Hiergesell & Sons
Precision Scientific Co.
Sargent & Co.

VISCOSIMETERS, Zahn
General Elec. Co.
Precision Scientific

VISCOSITY GAGES
Gerin Corp.

VISCOSITY REGULATORS (See Controllers, Automatic, Viscosity

VISCOSITY TUBES
Cargille, R. P.
Eitzen Co.
Fischer & Porter
Gardner Laboratory
Fish-Schurman Co.
Humboldt Mfg. Co.
Koehler Instrument
Phoenix Prec. Inst.
Precision Scientific

VOLTAGE ADJUSTERS, AUTOMATIC
Amplifier Co.
General Elec. Co.
Ideal Commutator Dresser
Lewis Co., J. B.
Rockwell Engr.
Sherron Metallic
Sola Electric Co.
Sorensen & Co.

VOLTAGE DETECTORS (See Detectors, Voltage)

VOLTAGE DIVIDERS, Radio Frequency (See Dividers, Voltage)

VOLTAGE, HIGH (above 2300 volts) Indicators
Ballantine Labs.
Bradshaw Instruments
Cole Instrument
Dale Instruments
Feiler Engineering
General Elec. Co.
General Physical Lab.
Ideal Commutator Dresser
Leeds & Northrup Co.
Meters, Inc.
Precision Apparatus
Rawson Electrical Inst.
Roller-Smith
Sensitive Research Inst.
Shallcross Mfg. Co.
Sherron Metallic
Triplett Electrical Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.

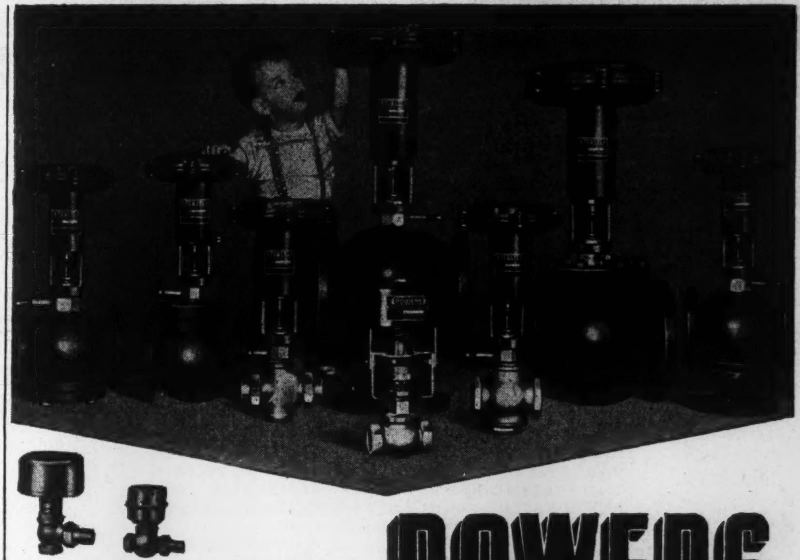
VOLTAGE, HIGH (above 2300 volts) Measuring Devices
Associated Research
Ballantine Labs.
Barber Labs., Alfred
Bradshaw Instruments
Cole Instrument
Electronic Instrument
Feiler Engineering
Ferranti Electric
Freed Transformer
Fox Valley Inst.
General Elec. Co.
International Resistance
Leeds & Northrup
Meters, Inc.
Precise Measurements
Precision Apparatus
Radio City Products
Rawson Elec. Inst. Co.
Reiner Electronics
Roller-Smith
Sensitive Research Inst.
Shallcross Mfg.
Sherron Metallic
Triplett Elec. Inst.
Westinghouse Elec.
Westinghouse X-Ray Co.
Weston Elec. Inst. Corp.

VOLTAGE, HIGH (above 2300 volts) Testing Devices
American Transformer
Associated Research
Bradshaw Instruments
Cole Instrument
Electronic Instrument
Feiler Engineering
General Elec. Co.
Industrial Insts., Inc.
International Resistance
MacLeod & Hanopol
Miller Co., Bertrand F.
Precise Measurements
Precision Apparatus
Radio City Products
Raytheon Mfg. Co.
Reiner Electronics
Roller-Smith Co.
S & C Electric
Sensitive Research Inst.
Shallcross Mfg. Co.
Sherron Metallic
Simpson Electric
States Co.
Superior Elec. Co.
Thordarson Elec. Mfg.
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.

VOLTAGE REGULATORS (See Regulators, Automatic, Voltage)

VOLTAGE SUPPLIES (See Power Supplies)

VOLT-AMMETERS
Am. Elec. Sales Co.
Assembly Products
Associated Research, Inc.
Bradshaw Instruments
Beckman Instruments
Burlington Inst. Co.
Clough-Brengle Co.
Cole Instrument
Dale Instruments
De Jur Amsco Corp.
Electro-Tech Equip. Co.
Electronic Dev. Lab.
Electronic Instrument
Esterline-Angus Co.
Feiler Engineering
Fox Valley Inst.
General Elec. Co.
Hickok Elec. Inst. Co.
International Instrument
Lewis Engineering
Meters, Inc.
Precision Apparatus Co.
Radio City Products
RCA Div.
Rawson Electrical Inst.
Reiner Electronics
Reliance Instrument Co.
Roller-Smith Co.
Sangamo Electric
Schauer Mfg. Co.
Sendur Mfg.
Sensitive Research Inst.
Simpson Electric Co.
Sticht Co.
Supreme Instruments
Triplett Electrical Inst.
U. S. Gauge
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.
Wheelco Instrument



Two of many different styles of pneumatic control valves for radiators, convectors and air conditioning units.

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Insure BETTER Control and Extra Years of Dependable Service

Compressed Air or Water Operated

VALVE TOP—Durable moulded neoprene diaphragm (1) has positive sealing bead which provides increased sealing action with increasing control pressure. Efficient diaphragm form insures ample and constant operating power thru full travel. Piston Plate Assembly (2) has a free floating thrust plate which absorbs side thrust. Closely guided piston plate maintains stem in accurate alignment.

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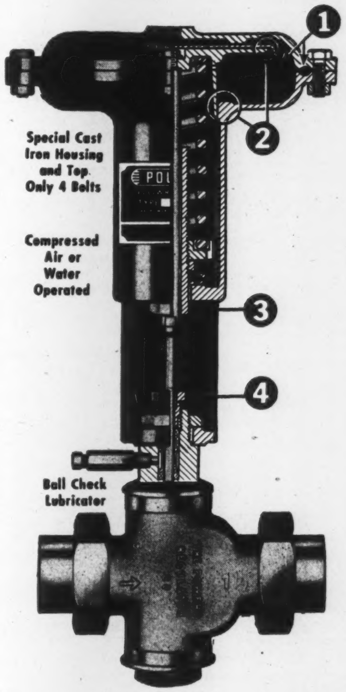
VARIETY of VALVE BODIES and TRIM Sizes ½" thru 8" —For line pressure up to 250 lbs. per square inch. Rugged construction to withstand piping strains. Single seat Stainless Steel V-Port, or double seat, bronze and stainless steel trim. Double unions and flanged ends. Available normally open (direct acting) or normally closed (reverse acting) and 3-way mixing type valves.



Special Cast Iron Housing and Top. Only 4 Bolts

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Ball Check Lubricator

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Back of every Simpson product is the combined and co-ordinated abilities of the industry's finest design engineers, outstanding production experts and highly skilled technical workmen. Every Simpson instrument is outstanding for greater ruggedness and accuracy, because of the full bridge-type construction and soft iron pole pieces.

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Model 27—D.C., Model 57—A.C., Model 37—R.F. 3" Rectangular Instrument, Bakelite Case

Model 25—D.C., Model 55—A.C. 3½" Round Instrument, Bakelite Case

Model 29—D.C., Model 59—A.C., Model 39—R.F. 4½" Rectangular Instrument, Bakelite Case

Model 126—D.C., Model 156—A.C. 2½" Round Instrument, Bakelite Case

Model 125 — D. C., Mode 155—A.C. 2½" Round Instrument, Bakelite Case

Model 127—D.C., Model 157—A.C. 2" Rectangular Instrument, Bakelite Case

Model 180 — Direct Current only. 1½" Threaded Ring Mounting Type, Bakelite Case

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VOLT OHM-MILLIAMMETER

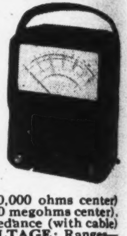
There are more Simpson 260 high sensitivity volt-ohm-milliammeters in use today than all others combined.

RANGES

Model 260 Volt-Ohm-Milliammeter 20,000 Ohms per Volt DC, 1,000 Ohms per Volt AC. Volts, AC and DC: 2.5, 10, 50, 250, 1000, 5000. Output: 2.5, 10, 50, 250, 1000. Milliamperes, DC: 10, 100, 500. Microamperes, DC: 100. Amperes, DC: 10. Decibels (5 ranges): —12 to+55 DB. Ohms: 0-2000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms. (120,000 ohms center).

New! SIMPSON 303 VACUUM TUBE VOLT-OHMMETER

The 303 can be used as an electronic DC voltmeter, an ohmmeter, an AC voltmeter, an AF voltmeter, an RF voltmeter (with accessory probe), an output-meter and an FM indicator; 60 to 70% more compact than any similar instrument. Low current consumption, wide voltage and resistance ranges make it an extremely versatile instrument.



SPECIFICATIONS

DC VOLTAGE: Ranges—1.2, 12, 60, 300, 1200 (30,000 with Accessory High Voltage Probe). Input Resistance—10 megohms for all ranges. DC Probe—with one megohm isolating resistor. Polarity reversing switch. **OHMS:** Ranges—1000 (10 ohm center). 100,000 (1000 ohms center). 1 megohm (10,000 ohms center) 10 megohms (100,000 ohms center). 1000 megohms (10 megohms center). **AC VOLTAGE:** Ranges—1.2, 12, 60, 300, 1200. Impedance (with cable) approx. 200 mmf shunted by 275,000 ohms. **AF VOLTAGE:** Ranges—1.2, 12, 60. Frequency Response—Flat 25 to 100,000 cycles. **DECIBELS:** Ranges— —20 to +3, —10 to +23, +4 to +37, +18 to +51, +30 to +63. Zero Power Level—1 M. W., 600 ohms. **GALVANOMETER:** Zero center for FM discriminator alignment and other galvanometer applications. **R. F. VOLTAGE:** (Signal tracing with Accessory High Frequency Crystal Probe). Range—20 volts maximum. Frequency—Flat 20 KC to 100 M.C. **LINE VOLTAGE:** 105-125 V. 50-60 cycles. **SIZE:** 5¼"x7"x3⅛" (bakelite case). Weight: 4 lbs. Shipping Wt.: 6½ lbs.

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AC and DC types, high accuracy, multiple ranges.
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ELECTROSTATIC VOLTMETERS
Ranges 100-v. to 35,000-v. AC or DC
Resistance exceeds million megohms.
Can measure static electricity.

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Laboratory and production measurements on magnets and magnetic circuits. Single push button return-to-zero.

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Our most recent development for measuring magnetic field strengths. Measures from a few gausses to 120 kilogausses.

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Sangamo Electric
Westinghouse Elec.

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General Elec. Co.
Hickok Elec. Instrument
Landis & Gyr, Inc.
Sangamo Electric
Sensitive Research Inst.
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst.

VOLTMETERS, A-c. Rectifier

Ballantine Labs.
Bradshaw Instruments
Burlington Instrument
Dale Instruments
De Jur-Amsco Corp.
Dittmore & Freimuth
Electronic Instrument
Feiler Engineering
General Electric Co.
General Radio Co.
Hewlett-Packard
International Instrument
Marion Electrical Inst.
Meters, Corp.
Roller-Smith
Sendur Mfg.
Simpson Electric Co.
Sterling Mfg. Co.
Triplett Elec. Inst.
U. S. Gauge Co.
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.

VOLTMETERS, Contact Making

Assembly Products
De Jur-Amsco
Cole Instrument
Edison Electrical Controls
Electric Des. & Mfg.
Electric Laboratory
Electric Tachometer Corp.
Electronic Development
Engineering Labs., Inc.
Esterline-Angus Co.
Ferranti Electric, Inc.
General Electric Co.
Geophysical Instrument Co.
Hickok Electrical Inst.

(Continued)

Lewis Engineering
Reliance Instrument Co.
Roller-Smith Co.
Triplett Elec. Inst.
Weston Electrical Inst.
Wheelco Instrument

VOLTMETERS, Electrostatic

Assembly Products
Cambridge Inst. Co.
Cole Instrument
Dittmore & Freimuth
Ferranti Electric, Inc.
General Elec. Co.
Hathaway Inst. Co.
Hickok Elect. Inst. Co.
Minnesota Electronics
Rawson Electrical Inst.
Sensitive Research Inst.
Sticht Co.

VOLTMETERS, Indicating

Assembly Products
Associated Research
Ballantine Labs.
Beede Elec. Instrument
Burlington Inst. Co.
Chicago Indust. Inst.
Clough-Brengle Co.
Cole Instrument
Columbia Elec. Mfg.
Control Corp.
Dale Instruments
De Jur-Amsco Corp.
Dittmore & Freimuth
Electric Des. & Mfg.
Electronic Development
Feiler Engineering
Ferranti Electric, Inc.
General Elec. Co.
Hickok Elec. Inst. Co.
International Instrument
J-B-T Insts.
Kay Electric
Lewis Engineering
Marion Electrical Inst.
Meters, Inc.
Miller, M. C.
Minnesota Electronics
Niagara Electrical Inst.
Precision Apparatus Corp.
Radio City Products Co.
Rawson Electrical Inst.
RCA Manufacturing Co.
Reiner Instrument
Reliance Instrument
Roller-Smith Co.
Sendur Mfg.
Sensitive Research Inst.
Shelby Inst.
Sierra Electronic
Simpson Elec. Co.
Sterling Mfg. Co.
Sticht Co.

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Sun Electric Corp.
Taco West Corp.
Triplett Elec. Inst.
Triumph Mfg. Co.
U. S. Gauge
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.
Wheelco Instrument
Winslow Co.

VOLTMETERS, Laboratory Standard

Ballantine Labs.
Beckman Instruments
Burlington Instrument
Electronic Instrument
Feiler Engineering
Ferranti Electric
General Electric Co.
Measurements Corp.
Rawson Elec. Inst.
Roller-Smith Co.
Sensitive Research Inst.
U. S. Gauge Co.
Welch Scientific
Weston Elec. Inst. Corp.

VOLTMETERS, Megohm

Assembly Products
Beckman Instruments
Beede Elec. Instrument
Cole Instrument
Dale Instruments
Daven Co.
Delmhorst Instrument
Electro Products Lab.
Electro-Tech. Equip. Co.
Electronic Dev. Lab.
Feiler Engineering
General Radio Co.
Hickok Elect. Inst. Co.
Industrial Control Co.
Industrial Insts. Inc.
Jackson Electrical Inst.
Precision Apparatus
Rawson Electrical Inst.
RCA Div.
Sensitive Research Inst.
Shallcross Mfg. Co.
Sticht Co.
Sun Manufacturing
Triplett Elec. Inst.
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.

VOLTMETERS, Micro

Ballantine Labs.
Cambridge Inst. Co.
Cole Instrument
Dale Instruments
De Jur-Amsco Corp.
Dittmore & Freimuth
General Electric Co.
General Radio Co.

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Hickok Elec. Inst. Co.
Industrial Control Co.
Microvolts, Inc.
Rawson Electrical Inst.
Sensitive Research Inst.
Supreme Instruments
Televiso Co.
Triplett Elec. Inst.
Welch Scientific
Weston Elec. Inst. Corp.
Wheelco Inst. Co.

VOLTMETERS, Micro, Radio Frequency

Ballantine Labs.
Burlington Inst. Co.
Clarke Inst. Corp.
Cole Instrument
Electric Des. & Mfg.
Feiler Engineering
Ferris Inst. Corp.
General Elec. Co.
General Radio Co.
Hickok Elec. Inst. Co.
Rollin Co.
Sensitive Research Inst.
Sylvania Elec. Prods.
Triplett Elec. Inst.

VOLTMETERS, Millivoltmeters

Assembly Products
Ballantine Labs.
Beckman Instruments
Bristol Co.
Brown Instrument Div.
Burlington Inst. Co.
Cambridge Inst. Co.
Cole Instrument
Commercial Research
Dale Instruments
De Jur-Amsco Corp.
Dittmore & Freimuth
Electric Des. & Mfg.
Electronic Development
Engelhard, Chas.
Esterline-Angus Co.
Feiler Engineering
Foxboro Co.
Freed Transformer
General Elec. Co.
Hickok Elec. Inst. Co.
International Instrument
J-B-T Insts.
Lewis Engineering
Marion Electrical Inst.
Meters, Inc.
Miller, M. C.
Millivac Instruments
Radio-City Products Co.
Rawson Electrical Inst.
RCA Manufacturing
Reiner Electronics
Reliance Instrument
Roller-Smith
Sensitive Research Inst.

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BALLANTINE

STILL THE FINEST IN ELECTRONIC VOLTMETERS

MODEL 300

MODEL 302B

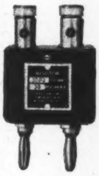
MODEL 304

MODEL 305

MODEL 310A

MODEL	FREQUENCY RANGE	VOLTAGE RANGE	INPUT IMPEDANCE	ACCURACY
300	10 to 150,000 cycles	1 millivolt to 100 volts	1/2 meg. shunted by 30 mmfds.	2% up to 100 KC 3% above 100 KC
302B Battery Operated	2 to 150,000 cycles	100 microvolts to 100 volts	2 megs. shunted by 8 mmfds. on high ranges and 15 mmfds. on low ranges	3% from 5 to 100,000 cycles; 5% elsewhere
304	30 cycles to 5.5 megacycles	1 millivolt to 100 volts except below 5 KC where max. range is 1 volt	1 meg. shunted by 9 mmfds. on low ranges. 4 mmfds. on highest range	3% except 5% for frequencies under 100 cycles and over 3 megacycles and for voltages over 1 volt
305	Measures peak values of pulses as short as 3 microseconds with a repetition rate as low as 20 per sec. Also measures peak values for sine waves from 10 to 150,000 cps.	1 millivolt to 1000 volts Peak to Peak	Same as Model 302B	3% on sine waves 5% on pulses
310A	10 cycles to 2 megocycles	100 microvolts to 100 volts	Same as Model 302B	3% below 1 MC 5% above 1 MC

MODEL 220A BATTERY OPERATED DECADE AMPLIFIER gives exact voltage gains of 10 or 100, permitting a corresponding increase in voltmeter sensitivity from 10 to 150,000 cycles.

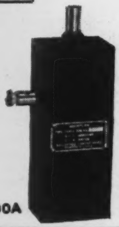


PRECISION SHUNT RESISTORS

Four different types of Precision Shunt Resistors, varying from 1 to 1000 ohms, permit the Voltmeters to be used to measure currents from 1 ampere to one-tenth of a microampere.

MULTIPLIERS

Five different types of Multipliers, whose input resistance varies from 5 to 40 megohms, permit the voltage range of the Voltmeters to be increased 10 or 100 times.



1300A

1300B

BALLANTINE pioneered circuitry and manufacturing integrity assure the maximum in

SENSITIVITY • ACCURACY • STABILITY

- All models have a single easy-to-read logarithmic voltage scale and a uniform DB scale.
- The logarithmic scale assures the same accuracy at *all* points on the scale.
- Multipliers, decade amplifiers and shunts shown above extend range and usefulness of voltmeters.
- Each model may also be used as a wide-band amplifier.

For further information, write for catalog

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Panel Type Electrical Instruments

furnished with round or square cases in standard and special ranges.

Portable Electrostatic Voltmeters

available in all high ranges in single and multiple scales.

Case style shown above also available in Portable Precision Electrical Instruments and Portable Precision Pyrometers.

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- Pyrometers—Portable and Mounted Types
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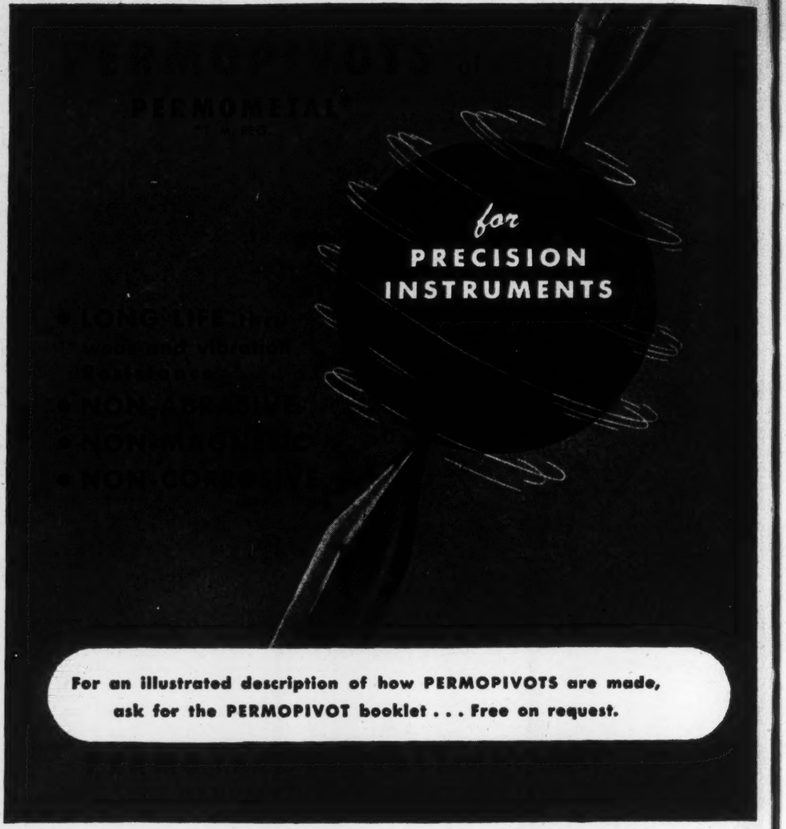

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Westinghouse Elec.
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Wheelco Inst. Co.

VOLTMETERS, Millivoltmeters, A-c, Rectifier

Ballantine Laboratories
Beckman Instruments
Burlington Instruments
Dale Instruments
De Jur-Amsco Corp.
Dittmore & Freimuth
Electronic Development
Electronic Instrument
Feiler Engineering
General Electric
Hewlett-Packard
International Instruments
Marion Electrical Inst.
Prec. Apparatus Co.
Roller-Smith Co.
Triplett Elec. Instrument
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.

VOLTMETERS, Oxide Rectifier

Assembly Products
Clough-Brengle Co.
Cole Instrument
Dale Instruments
De Jur-Amsco Corp.
Electric Des. & Mfg.
Electronic Dev. Lab.
Feiler Engineering
General Elec. Co.
General Radio Co.
Hickok Elec. Inst. Co.
Marion Electrical Inst.
Meters, Inc
Precision Apparatus
Radio City Products Co
Reiner Electronics
Reliance Instrument
Roller-Smith
Simpson Elec Co.
Sun Manufacturing
Supreme Instruments
Taco West Corp.
Triplett Electrical Inst.
Triumph Mfg. Co.
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.
Hickok Elec. Inst. Co.

VOLTMETERS, Peak

Ballantine Labs.
Barber Labs., Alfred
Clarke Inst. Corp.
Clough-Brengle Co.
Cole Instrument
Electronic Dev. Lab.
Feiler Engineering
Fox Valley Inst.
General Elec. Co.
General Radio Co.
Hickok Elec. Inst. Co.
Kay Electric
Measurements Corp.
Rawson Elec. Instrument
RCA Mfg. Co.
Rowe Engineering
Sensitive Research Inst.
Simpson Elec.
Triplett Elec. Inst.

VOLTMETERS, Recording

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Bristol Co.
Brush Development
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Cole Instrument
Engelhard, Chas.
Esterline-Angus Co.
Fielden Instrument
General Elec. Co.
Leeds & Northrup Co.
Massa Labs.
Precise Measurements Co.
Roller-Smith
Sanborn Co.
Southwestern Ind. Elec.
Sound Apparatus
Sticht Co.
Westinghouse Elec.
Wheelco Instrument

VOLTMETERS, Thermionic Rectifier

Ballantine Labs.
Barber Labs., Alfred
Cambridge Inst. Co.
Clippard Inst. Lab.
Cole Instrument
Electronic Dev. Lab.
General Elec. Co.
General Radio Co.
Measurements Corp.
Meters, Inc.
Triplett Elec. Inst.

VOLTMETERS, Thermo

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Cole Instrument
Dale Instruments
De Jur-Amsco Corp.
Electronic Development
General Elec. Co.

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Lewis Engineering
Meters, Inc.
Rawson Electrical Inst.
Sensitive Research Inst.
Sun Manufacturing
Triplett Electrical Inst.
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.
Wheelco Inst. Co.

VOLTMETERS, Vacuum Tube

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Bradshaw Instruments
Cambridge Inst. Co.
Clippard Inst. Lab.
Clough-Brengle Co.
Cole Instrument
Dayton Acme Co.
Electronic Dev. Lab.
Electronic Instrument
Electronic Mfg. Co.
Electro Products Lab.
Feiler Engineering
Freed Transformer
General Elec. Co.
General Radio Co.
Hewlett-Packard
Hickok Elec. Instrument
Industrial Control Co.
Instrument Electronics
Jackson Elec. Co.
Measurements Corp.
Millen Mfg. Co.
Miller, M. C.
Millivac Instruments
Minnesota Electronics
Precision Apparatus Co.
Radio City Products Co.
RCA Div.
Reiner Electronics
Shallcross Mfg. Co.
Sherron Metallic
Southwestern Ind. Elec.
Sylvania Elec. Prod.
Televiso Co.
Triplett Electrical Inst.
Triumph Mfg. Co.
Victoreen Instrument
Welch Scientific
Weston Elect. Inst. Corp.

VOLT-OHMMETERS

Associated Research
Beckman Instruments
Beede Elec. Instrument
Bradshaw Instruments
Burlington Inst. Co.
Chicago Indust. Inst.
Clippard Inst. Lab.
Clough-Brengle Co.
Cole Instrument

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Dale Instruments
DeJur-Amsco Corp.
Douglas Radio Labs.
Electronic Dev. Lab.
Electronic Instrument
Feiler Engineering
General Elec. Inst. Co.
Hickok Elec. Inst. Co.
Instruments Labs.
Jackson Electrical Inst.
Meters, Inc.
Precision Apparatus Corp.
Radio City Prod.
Rawson Electrical Inst.
RCA Div.
Reiner Electronics
Roller-Smith
Sensitive Research Co.
Shallcross Mfg. Co.
Sherron Metallic
Simpson Elec. Co.
Sticht Co.
Superior Instruments
Taco West Corp.
Triplett Electrical Inst.
Triumph Mfg. Co.
Universal Inst. Co.
Welch Scientific
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

VOLT-OHM-MILLIAMMETERS

Bradshaw Instruments
Dale Instruments
Electronic Development
Electronic Instrument
Feiler Engineering
International Instruments
Instruments Labs.
Jackson Elec. Inst.
Marion Electrical Inst.
Meters, Inc.
Millivac Instruments
Precision Apparatus Co.
RCA Div.
Roller-Smith Co.
Simpson Electric Co.
Triplett Elec. Instrument
Welch Scientific
Westinghouse Elec.
Weston Elec. Inst. Corp.

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Centralab Div.
Clarostat Mfg. Co.
Daven Co.
General Radio Co.
Internat'l Resistance
Mallory & Co.
Poole Mfg.

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Shallcross Controls
Shallcross Mfg. Co.
Southwestern Ind. Elec.
Triumph Mfg. Co.
U. S. Gauge
Utah Radio Prods.

VOLUME INDICATORS Sound
Amplifier Co.
Cole Instrument
Dale Instruments
Daven Co.
Electronic Development
Feiler Engineering
General Radio Co.
Meters, Inc.

WATCHES, Chronometer
Bliss & Co.
Clebar Watch Co.
Ducommun Co.
Elgin National Watch
Hamilton Watch
Jaeger Watch Co.
Jardur Import Co.
Negus, T. S. & J. D.
Pastor Stop Watch
Sticht Co.
Technical Instruments
Waltham Watch

WATCHES, Comparing
Clebar Watch Co.
Ducommun Co.
Elgin National Watch
Hamilton Watch Co.
Jardur Import Co.
Negus, T. S. & J. D.
Waltham Watch Co.

WATCHES, Navigation
Clebar Watch Co.
Ducommun Co.
Elgin National Watch
Hamilton Watch Co.
Jardur Import Co.
Meridian Instrument
Negus, T. S. & J. D.
Waltham Watch Co.

WATCHES, Stop
Aristo Import Co.
Biddle Co., James G.
Central Scientific Co.
Clebar Watch Co.
Ducommun Co.
Elec. Facilities, Inc.
Elgin National Watch
Fish-Schurman Co.
Fisher Scientific Co.
Gaertner Scientific Corp.
Gallien, R. P.
Hamilton Watch
Jaeger Watch Co.
Jardur Import Co.
Negus, T. S. & J. D.
Pastor Stop Watch Co.
Pierce Scientific Co.
Precision Scientific Co.
Racine & Co., Jules
Scherr Co., Inc.
Speidel & Co.
Standard Elec. Time
Sticht Co.
Stoelting Co., C. H.
Tagliabue Div.
Testrite Instrument Co.
Waltham Watch
Warren Telechron
White Co.
Zernickow Co., O.

WATCHES, Stop-Electric
Central Scientific Co.
Clebar Watch Co.
Elgin Natl. Watch Co.
Jaeger Watch Co.
Jardur Import
Precision Scientific Co.
Standard Elec. Time
Sticht Co.
Stoelting Co., C. H.
Tagliabue Div.
Thompson Clock Co.
Waltham Watch

WATER ANALYSIS OUTFITS
Beckman Instruments
Gerin Corp.
Hagan Corp.
Hellige, Inc.
Howe & French, Inc.
La Motte Chemical Prods.
Taylor & Co., W. A.

WATER BATHS, Constant Temperature (see Viscosimeter Baths)

WATER FEEDERS Automatic
Askania Regulator Co.
Bailey Meter Co.
Climax Div.
Fischer & Porter
Henszey Co.
Kieley & Mueller
Magnetrol, Inc.
Mason-Neilan Regulator
McAlear Mfg.
Merritt Eng. & Sales Co.
Northern Equip. Co.
Penberthy Injector Co.
Photoswitch, Inc.
Watts Regulator Co.

WATER METERS (See Liquid Meters)

WATER METER TESTERS (See Testers, Water Meter)

WATER & SEDIMENT APPARATUS
Barnstead Still
Central Scientific Co.
Davis Reg. Co.
Henry Valve
Instruments Corp.
McAlear Mfg. Co.
Precision Scientific Co.
Tagliabue Div.
Thomas Co., Arthur H.

WATTHOUR METERS (See Meters, Watt-Hour)

WATTHOUR METER TESTERS (See Testers Watthour Meter)

WATTMETERS, Electrostatic
General Electric Co.
Hickok Elec. Instrument
Sensitive Research Inst.

WATTMETERS, Indicating
Autocall Co.
Cole Instrument
General Elec. Co.
Hickok Elec. Inst. Co.
Landis & Gyr
Niagara Elec. Inst.
Norton Electrical Inst.
Rawson Electrical Inst.
Reliance Instrument Co.
Roller-Smith Co.
Sensitive Research Inst.
Sticht Co.
Welch Scientific
Triplett Elec. Inst.
Westinghouse Elec.
Weston Elec. Inst. Corp.

WATTMETERS, Laboratory Standard
Bird Electronic
Electrical Facilities Inc.
General Electric Co.
Rawson Elec. Inst.
Roller-Smith Inst.
Triplett Elec. Instrument
Welch Scientific

WATTMETERS, Microwave
Bird Electronic
Hewlett-Packard Co.
Rollin Co.
Sperry Gyroscope Co.

WATTMETERS, Recording
Bristol Co.
Cole Instrument
Esterline Angus Co.
General Elec. Co.
Hathaway Instrument
Hickok Elec. Inst.
Roller-Smith
Sensitive Research Inst.
Sticht Co.
Westinghouse Elec.

WATTMETERS, Reactive
Esterline-Angus
General Electric Co.
Roller Smith
Westinghouse Elec.

WAVE METERS
Antenna Research Lab.
Clarke Inst. Corp.
Electronic Dev. Lab.
Federal Telephone
General Electric
General Radio Co.
Jones Electronics
Kay Electric
Millen Mfg. Co.
RCA Manufacturing
Sperry Gyroscope Co.
Vectron, Inc.

WAX MELTING APPARATUS
Central Scientific Co.
Fisher Scientific Co.
Koehler Instrument
Precision Scientific Co.
Tagliabue Div.

WEIGHT INDICATORS, Automatic Recording
Exact Weight Scale Co.
Foxboro Co.
Howe Scale Co.
Merrick Scale Mfg.
Roller-Smith Co.
Streeter-Amet Co.
Toledo Scale Co.
Wiancko Engineering

WEIGHING MACHINES (See various headings under "Scales—")

WEIGHTS, Analytical
Ainsworth & Sons
Aloe Co., A. S.
Becker Div., Christian
Central Scientific Co.
Dietert Co.
Exact Weight Scale Co.
Fisher Scientific Co.
Gurley, W. & L. E.
Howe Scale Co.
Ohaus Scale Corp.
Roller Smith
Seedburo Equipment
Seederer-Kolbusch, Inc.
Thomas Co., Arthur H.
Thompson Balance
Troemmer, Henry
Voland & Sons, Inc.
Welch Scientific

WEIGHTS, Avoirdupois
Becker Div., Christian
Central Scientific Co.
Exact Weight Scale Co.
Gurley, W. & L. E.
Howe Scale Co.
Ohaus Scale Corp.
Seederer-Kohlbusch, Inc.
Toledo Scale Co.
Troemmer, Henry
Voland & Sons, Inc.

WEIGHTS, Metric
Ainsworth & Sons
Becker Div., Christian
Central Scientific Co.
Chicago Apparatus Co.
Exact Weight Scale Co.
Gaertner Scientific Corp.
Gurley, W. & L. E.
Humboldt Mfg. Co.
Ohaus Scale Corp.
Seederer-Kohlbusch, Inc.
Suter, Alfred
Thompson Balance
Toledo Scale Co.
Troemmer, Henry
Voland & Sons, Inc.
Welch Scientific Co.

WEIGHTS, Test (See Weights, Avoirdupois, Metric or Troy)

WEIGHTS, Troy
Becker Div., Christian
Central Scientific Co.
Exact Scale Co.
Gurley, W. & L. E.
Howe Scale Co.
Ohaus Scale Corp.
Seederer-Kohlbusch, Inc.
Toledo Scale Co.
Thompson Balance
Troemmer, Henry
Voland & Sons

WEIGHTS & MEASURES PRECISION STANDARD
Gurley, W. & L. E.
Jacobs Bros. Co.
Pfaltz & Bauer, Inc.
Seederer-Kohlbusch, Inc.
Thompson Balance
Torsion Balance Co.
Troemmer, Henry
Voland & Sons

WEIR METERS (See Flowmeters, Weir)

WELLS, Thermocouple see Tubes, Pyrometer

WIND DIRECTION & VELOCITY INDICATORS
Alfax Paper & Eng.
Doelcam Corp.
Electric Speed Ind. Co.
Elec. Tachometer Corp.
Friez Instrument
General Elec. Co.
Geophysical Inst. Co.
Green, Henry J.
Hastings Inst. Co.
Hays Corp.
Illinois Testing Labs.
Kenyon Instrument Co.
Stewart, M. C.
Taylor Instrument Cos.
Westberg Mfg. Co.
Westinghouse Elec.

WIND DIRECTION & VELOCITY RECORDERS
Doelcam Corp.
Elec. Tachometer Corp.
Friez Instrument
General Electric Co.
Geophysical Instrument
Green, Henry J.
Hastings Inst. Co.
Hays Corp.
Hickok Elec. Instrument
Illinois Testing Labs.
Instruments Corp.
Kenyon Instrument Co.
Leeds & Northrup Co.
Stewart, M. C.
Wallace & Tiernan
Westinghouse Elec.
Zeiss, Inc., Carl.

WIND GAGES (See Gages, Wind)

WIND TUNNEL INSTRUMENTS
Askania Regulator
Automatic Temp. Control
Gaertner Scientific
Huggins Labs.
Illinois Testing Labs.
Industrial Electronics
Potter Instrument
Stratex Instrument
Tinsley Labs.
Toledo Scale
Wiancko Engineering

WIRES, Gear Measuring
Acme Industrial
Van Keuren Co.
Size Control Co.

WIRES, Thermocouple (See Under Thermocouples)

WIRES, Thread Measuring
Brown & Sharpe
Elgin National Watch
Ferner Co.
Scherr Co., Inc.
Sheffield Gage
Size Control Co.
Van Keuren Co.

WOW METER
Brush Development
Furst Electronics
Kay Electric Co.

X-RAY CAMERAS, Difraction
American Inst. Co.
Baird Associates
Distillation Products, Inc.
Farrand Optical Co.
General Elec. X-Ray Dept.
Hayes Scientific App.
Jarrel-Ash Co.
North Amer. Phillips
Picker X-Ray
RCA Div.
Summers Gyroscope
Wyland, G. C.

X-RAY EQUIPMENT
Allis-Chalmers
Aloe Co., A. S.
Baird Associates
Bar-Ray Products
Campbell Electric
Fish-Schurman Co.
General Elec. X-Ray Dept.
Hayes Scientific App.
High Voltage Eng.
Industrial X-Ray Labs.
Jarrell-Ash Co.
Kelley-Koett Mfg. Co.
North Amer. Philips
Patterson Screen Co.
Picker X-Ray
Shallcross Mfg. Co.
Stoelting Co., C. H.
Universal X-Ray Prods.
Westinghouse Elec.
Westinghouse X-Ray Co.
Wyland, G. C.

X-RAY FLUOROSCOPIC SCREENS (See Screens, X-Ray Fluoroscopic)

X-RAY INTENSIFYING SCREENS (See Screens, X-Ray Intensifying)

X-RAY MEASURING INSTRUMENTS
Canadian Radium
Cyclotron Specialties
Herbach & Rademan
High Voltage Engg.
Instrument Dev. Labs.
Martin-Hubbard Corp.
Radiation Counter Labs.
Technical Associates
Victoreen Inst. Co.

X-RAY SPECTROGRAPHS (See Spectographs, (X-Ray)

X-RAY SPECTROMETERS

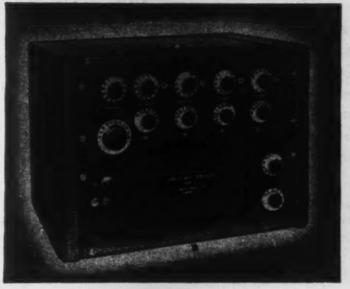
X-RAY STEREOSCOPE (See Stereoscope, X-Ray)

X-RAY TUBES (See Tubes, X-Ray

X-RAY VOLTMETER, High Potential
Bradshaw Instruments
Cole Instrument
General Elec. X-Ray Dept.
Hickok Elect. Inst. Co.
Kelley-Koett Mfg. Co.
Meters, Inc.
Precise Measurements Co.
Rawson Elec. Inst. Co.
Shallcross Mfg. Co.
Westinghouse Elec.

Z-ANGLE METER, Audio Frequency
Kay Electric Co.
Marconi Insts. Ltd.
Technology Inst. Corp.

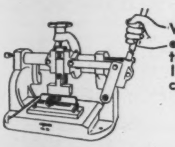
Z-ANGLE METER, Radio Frequency
Marconi Insts., Ltd.
Technology Inst. Corp.


COMPLEX WAVE GENERATOR

SPECIFICATIONS:
FUNDAMENTAL: 50 - 3000 cycles
HARMONICS: 2nd, 3rd, 4th and 5th
PHASE: Each Harmonic 0 to ± 180°
AMPLITUDES: Each Harmonic 0 to 100%
OUTPUT: 1 volt of Fund. or Harmonic

APPLICATIONS:
Wave Form Study, Distortion Measurement, Phase Study, Syncro Mechanism Response, Fourier Wave Synthesis, Teaching, Study and Measurement.

ALFRED W. BARBER LABORATORIES
32-44 Francis Lewis Boulevard, Flushing, N. Y.


MACHINES for MARKING & NUMBERING

HAND
MOTOR
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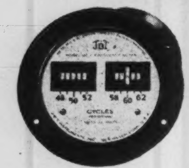
"The most complete line of machines and tools for marking in AMERICA." Equipment for marking and stamping, embossing, printing and stenciling methods. Steel type, stamps, numbering and marking machines carried in stock.

Write for new general catalog illustrating more than 150 tools and machines for marking.

The ACROMARK Company
3-11 Morrell St.
ELIZABETH 4, N.J.

VIBRATING REED FREQUENCY METERS

Panel Mounting or Portable, for use when constant or known frequency is important to efficient operation of equipment.

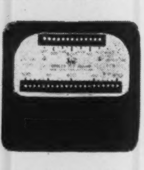


- **Permanently Accurate** within ±0.3% or better, depending on the model. This accuracy is not affected by poor wave form, external magnetic disturbances, or voltage fluctuations.
- **Size and Type for Every Service.** Made in a wide variety of portable and panel case styles, reed groupings and frequency ranges from 12 to 525 cycles and above; 100-130 volts is standard.
- **Rugged Construction** of simplified, patented design, with no moving parts to wear out or get out of calibration. Ideal for field and mobile applications.

Ask for Bulletins VF-43, VF-43-1A-1B-1C-1D, and General Catalog 451

NEW DEVELOPMENT

400 Cycle Dual Range — 2, 5 and 10 Cycle Steps



Model 41-FX — Designed originally for high-quality electrical analyzers of heavy aircraft, this 4" meter is finding many additional applications. The top window with 13 reeds gives a vernier effect indicating 380-420 cycles, with 2 cycle increments in the critical range of 396-404 cycles. The bottom window frames 21 reeds 300-500 cycles in 10 cycle steps for a general idea of the frequency under test. When used with external switching, three voltages: 200-240; 115; and 30 volts can be supplied.

Where 400 cycle readings are important, the Model 41-FX is the all-round working standard — precise for the laboratory, rugged for shop and field.

ELAPSED TIME METERS

For Maintenance, Tube Life Data, and Operating Time Records—on Motor Generators, Transmitters, Receivers, Rectifiers, Test Set-ups, etc.

ELAPSED TIME METER
HOURS

Model 31-EX (illustrated) also known as running-time or total time meter, registers in 1/10 hours to 9,999.9 hours, then automatically resets. Normally stocked for 60 cycles, 110-130 volts. 3½" standard meter mounting. Variations such as 50 cycles; 230 volts; 0-99,999 hours; and 3" rectangular case available on special order.

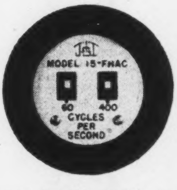
SEALED TIME METERS

Model 31-EHXX—Completely sealed meter, reading 0-9,999.9 hours, same as Model 31-EX above. Glass-to-metal construction, solder terminals, and 3½" detachable flange, all match XX metal frequency meter case. For mounting, use Sketch SK-53. While not presently stocked, these meters are in production.

3½" *SEALED* Frequency Meters

FHXX Type Meters, sealed, glass-to-metal construction, with solder terminals, meets or exceeds the sealing and electrical requirements of JAN-I-6 and MIL-M-6A including the 3000 volt breakdown, and uses the front mounting dimensions specified. Max. barrel diameter, 2 11/16"; 2⅞" overall depth behind flange. Various reed groupings and frequency ranges from 12 to 525 cycles and above; 100-130 volts standard. While not regularly stocked, these meters are in production. See print SK-51, and Catalog 451.

1½" *SEALED* Frequency Meters



Model 15-FHAC (illustrated half actual size). 60 and 400 cycles, 2 reeds, 8-10 volts, for cathode follower circuit. Widely used on audio oscillators to standardize output. Meets intent JAN-I-6 and amendments on sealed meters. Barrel, 1½" diameter; detachable flange, 2.094" diameter; solder terminals.

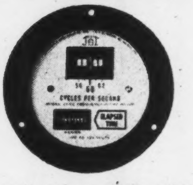
Model 15-FH (not illustrated)--same case, sealed, 5 reeds, 58-62 cycles, 100-130 volts. Variations such as 6 reeds, 25 or 400 cycle ranges and higher voltages available on special order.

NOTE ON METER VOLTAGE

J-B-T Vibrating Reed Frequency Meters of all sizes normally are made with two studs and are designed to be connected across one phase of a multi-phase line. The single phase voltage where the meter will be used thus becomes the voltage to be specified for the meter. Special meters with extra studs are made only for the purpose of reading two or more voltages, not additional phases.

FREQUENCY-TIME METERS

Combination Reed-Type Frequency-Elapsed Time Meters — One Meter Does The Work of Two

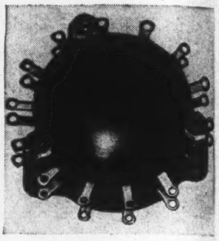


Model 31-FE (illustrated) pioneered by J-B-T, saves panel space and cost. Useful on electrical and electronic equipment, also power units, where both frequency and periodic maintenance are important. 3¼" flange, metal case, 4 11/32" overall depth standard. 3½" case, known as 31-FEX-1 supplied on custom orders. 5 reeds, 60 cycle range, standard; 7, 9, 11 reeds or 50 cycle range on special order. For other details, see Elapsed Time Meters in column to the left.

ROTARY SELECTOR SWITCHES

INSTRUMENT TYPE MOLDED SWITCHES

Fully Enclosed Single and Multi-Gang Shorting and Non-Shorting* 14 and 20 Positions 1 to 6 Decks



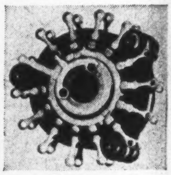
Model MS-14-2

- All moving contacts enclosed — eliminates dirt and corrosion.
- Contact lugs permanently integrated into switch assembly.
- Sturdy construction with 3-post deck suspension, double-grip collector arms, and rectangular drive shaft through decks for precision indexing.
- Interchangeable, electrically and mechanically with J-B-T Series SS-14 and 20 position Laminated Switches, widely used by industry and the Armed Services.

Normal carrying capacity (not make-and-break) 1 amp.; maximum momentary capacity (not make-and-break) 5 amp.; maximum voltage between contacts and ground, 1000 volts R.M.S.; between decks and ground, 2000 volts R.M.S. Average contact resistance 0.007 ohms or less.

**Ask for Catalog 451*

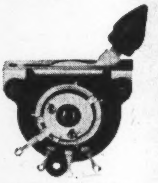
INSTRUMENT TYPE LAMINATED SWITCHES



Model SS-14-2

Used widely in quality test equipment, portable instruments, inspection setups and avionics where trouble-free, dependable performance is of major importance. Available in two basic types — 14 and 20 position — the design gives extra contacts in minimum space. One to six decks.

LEVER ACTION SWITCHES



Model SS-14-16H

Excellent for test equipment and communications systems, these switches use the same high quality parts as the SS-14 series. Bracket mounting holes 1⅝" apart; may be mounted in groups ⅝" between centers. Individually boxed with knobs. Positive indexing type. Available with 3 pos. or 4 pos., Shorting or Non-Shorting.

OTHER J-B-T PRODUCTS

APPLIANCE TEMPERATURE TESTERS
TEMPERATURE INDICATORS
LABORATORY GALVANOMETERS
VACUUM TUBE FREQUENCY METERS

DISTRIBUTOR SERVICE

Standard J-B-T items are available through authorized electronics parts distributors.

J-B-T INSTRUMENTS, INC.

443 CHAPEL STREET
NEW HAVEN 8, CONN.

DESCRIPTIVE DIRECTORY

Of Manufacturers and Sole Representatives Selling Instruments and Devices Used for Measurement, Inspection, Testing and Automatic Control

Advertisers are indicated by bold-face type

These Manufacturers Produce Instruments and Devices for measurement, inspection, testing and control for increased productivity.

A

Abrams Instrument Co., 606 E. Shiawasse St., Lansing, Mich.
Aerial Cameras, Stereoscopes, Triangulators, Mapping Projectors, Aerial Surveying Instruments

Accuracy Scientific Instruments Co., 2903 N. 12th St., Philadelphia 33, Pa.
Thermometers, hydrometers, thermo-hydrometers, thermo-regulators

Accurate Pyrometric Cone Co., Pataskala, Ohio
Seger cones

Accurate Instrument Co., Inc., 3456 N. Clark St., Chicago 13, Ill
Thermometers

Ace Glass Inc., Vineland, N. J.
Chemical & laboratory glassware

Ace Instrument Co., Inc., 172 Pacific St., Brooklyn 2, N.Y.
Combustion control instruments

Acme Industrial Co., 1512 W. Lake St., Chicago, Ill.
Machine shop gages

Acme Regulator Co., Box 268, Tulsa 1, Okla.
High Pressure regulators

Acme Scientific Co., 1450 West Randolph St., Chicago 7, Ill.
Optical flats and light sources

Acragage Co., Wampus Lane, Milford, Conn.
Pressure, vacuum and liquid level instruments
(See advertisement on page 73)

Acromark Co., 3-11 Morrell St., Elizabeth 4, N. J.
Engraving, numbering and marking machines
(See advertisement on page 155)

Acro Switch Div., Acro Mfg. Co., 2030 E. Main St., Columbus 9, Ohio
Snap action switches

Adams & Westlake, Elkhart, Ind.
Relays

Adde & Co., 57 Kennebec St., Portland 2, Maine
Counters

Adel Precision Products Corp., 10777 Van Owen St., Burbank, Calif.
Hydraulic actuators and remote control equipment

Advance Electric & Relay Co., 2435 N. Naomi St., Burbank, Calif.
Relays
(See advertisement on page 115)

Aero Electronics Co., 1902 W. Division St., Chicago 22, Ill.
Aircraft and industrial instruments

Aero Instrument Co., 11423 Vanowen St., No. Hollywood, Calif.
Airbourne and ground-station instruments

Aero Instrument Co., 5105 Denison Ave., Cleveland 2, Ohio
Airspeed tubes

Aerolite Electronic Hardware Corp., 507 26th St., Union City, N. J.
Radio hardware, connectors

Aeromarine Instrument Co., Inc., 385 Gerard Ave., New York 51, N. Y.
Aircraft, marine and industrial instruments
(See advertisement on page 76)

Aeroquip Corp., 300 South East St., Jackson, Mich.
Dynamic pressure gages

Aerovox Corporation, New Bedford, Mass.
Capacitors & resistors

Agfa Ansco, Binghamton, N. Y.
Electronic photometer

Ahrendt Instrument Co., 4910 Calvert Rd., College Park, Md.
Power supplies; servomechanism testers

Ainsworth & Sons, Inc. Wm., 2151 Lawrence St. Denver 2, Colo.
Analytical, micro, assay & pulp balances & weights, pocket transits

Air Instrument Corp., 1562 Main St., Springfield, Mass.
Height Gages

Airbourne Instruments Laboratory, Inc., 160 Old Country Rd., Mineola, L. I., N. Y.
Polar and rectangular coordinate recorders, electronic instruments

Aircraft Electronics Associates, Inc., 94 Silas Deane Highway, Rocky Hill, Conn.
Aircraft instruments and testers

Aircraft-Marine Products, Inc., 1521-39 No. 4th St., Harrisburg, Pa.
Repair kits, connectors

Aircraft Radio Corp., Boonton, N. J.
Electronic instruments

Airdesign Incorporated, 241 Fairchild Ave., Upper Darby, Pa.
Audio-frequency equipment, transformers

Airdraulics Engineering, Inc., Overhill Ave., Rye, N. Y.
Torque Testers

AiResearch Mfg. Co., 9851 Spulveda Blvd., Los Angeles 45, Calif.
Airbourne and ground-station instruments, computers, actuators

Airflo Instrument Co., 122 Naubuc Ave., Glastonbury, Conn.
Special probes for measuring gas velocity, direction, temperature and pressure

Airite Products Co., Inc., 3528 Union Pacific Ave., Los Angeles 23, Calif.
Fire detectors

Airplane & Marine Instruments, Inc., Clearfield, Pa.
Absolute pressure gage

Alden Products Co., Inc., 117 N. Main St., Brockton 64, Mass.
Oscillographs, radiosondes, fascimile recorders

Alfab Manfacturing Co., 8320 Millet St., Houston 12, Texas
Laboratory furniture

Alfax Paper & Engr. Co., Washington St., Westboro, Mass.
Accelerometers, barometers & clinometers

Alina Corp., 32 Broadway, New York 4, N. Y.
Clocks, differential pressure gages, time meters and switches, toolmakers' microscopes

All American Tool & Mfg. Co., 1014 W. Fullerton Ave., Chicago 14, Ill.
Vibration fatigue testers
(See advertisement on page 131)

Allen-Bradley Co., 136 W. Greenfield St., Milwaukee 4, Wis.
Electric control apparatus

Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.
Relays, switches & remote control equipment

Allied Engraving & Stamping Co., 161 Elliott St., Buffalo 3, N. Y.
Instrument panels

Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.
Amplifiers and audio-frequency equipment

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.
Position indicators, frequency load & phase regulators

Alpha Instrument Co., 2103 K St., N. W., Washington 7, D. C.
Meteorological instruments

Alpha-Lux Co., Inc., 155 John St., New York, N. Y.
Moisture testers

Altender & Sons, Theo., 1219 Spring Garden St., Philadelphia 23, Pa.
Drawing instruments

Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh 19, Pa.
Aluminum instrument tubing

American Blower Corp., 6000 Russell St., Detroit 32, Mich.
Manometers

American Chain & Cable Co., Helcoid Gage Div., 929 Connecticut Ave., Bridgeport 2, Conn.
Bourdon tube gages & pressure indicators
(See advertisement on page 75)

American Chronoscope Corp., 316 W. First St., Mt. Vernon, N. Y.
Time study instruments, steam meters

American Communications Corp., 308 Broadway, New York 7, N. Y.
Audio-frequency equipment, battery chargers, instrument panels

American Condenser Co., 4410 Ravenwood Ave., Chicago, Ill.
Capacitors

American Cystoscope Makers, Inc., 1241 Lafayette Ave., New York 59, N. Y.
Bore inspection devices and internal surface inspection devices

American Electroneering Corp., 5025 W. Jefferson Blvd., Los Angeles 16, Calif.
Electronic instruments

American Gage Co., 143 17th Ave., Paterson 3, N. J.
Profile, ring and snap gages

American Gas Accumulator Co., 1029 Newark Ave., Elizabeth, N. J.
Time delay relays

American Indicator-Paper Co., 4611 N. Kostner Ave., Chicago 30, Ill.
Chemical indicator papers

American Instrument Co., 8010-8020 Georgia Ave., Silver Spring, Md.
Scientific instruments & materials testing apparatus

American Lens Co., 45 Lispenard St., New York, N. Y.
Cathode-ray tubes and lenses

American Measuring Instruments Corp., 240 W. 40th St., New York 18, N. Y.
Precision measuring instruments

American Meter Co., 1513 Race St., Philadelphia 2, Pa.
Tinned case & ironcase positive displacement gas & air meters, pressure reducing regulators, meter testing apparatus, indicating, recording & integrating flowmeters, rate volume & liquid level controllers & remote controllers
(See advertisement on page 19)

American Optical Co., Instrument Div., Box A, Buffalo 15, N. Y.
Scientific optical instruments, projection apparatus, testing equipment and optical parts, microscopes, microtomes, refractometers, spectrometers, visual colorimeters, illuminators, delineascopes, magnifiers, and special lenses, prisms and mirrors for industrial and educational purposes.

American Paulin System, 1874 So. Flower St., Los Angeles 15, Calif.
Meteorological instruments, altimeters, barometers
(See advertisement on page 48)

American Relay & Controls, Inc., 4901 W. Flournoy St., Chicago 44, Ill.
Relays, switches, coils, etc.

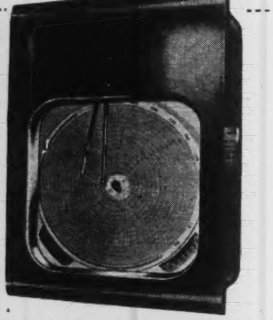
American Temperature Indicating Co., 1017 Summit St., Toledo 4, Ohio
Electrical resistance thermometers

American Thermo-Electric Co., 67 East 8th St., New York 3, N. Y.
Vacuum, separate heater & contact type thermocouples
(See advertisement on page 134)

American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Timing Systems, frequency standards
(See advertisement on page 36)

American Transformer Co., 178 Emmet St., Newark, N. J.
Transformers & electrical apparatus including voltage regulators, high voltage testing sets, rectifiers

BRISTOL'S
SERIES 500
AIR-OPERATED
Automatic Controllers



Reproduces previously-established control actions . . . duplicates control actions in any other Series 500 Controller . . . easily, accurately. So you can standardize controller adjustments . . . save cut-and-try methods of duplicating settings.
Simplest control system to service. Only one service adjustment needed. Almost anybody can service a Series 500 Controller.
Five types of control: on-and-off, proportional, proportional plus derivative, reset, reset plus derivative.
Available for temperature, pressure, liquid level, flow, humidity and pH.

Write for Bulletins A120, A115 and C305.

THE BRISTOL COMPANY
113 BRISTOL RD., WATERBURY 20, CONN.

Amerline, 1753 N. Honore St., Chicago 22, Ill.
Radio tube testers; spark plug testers

Ames Co., B. C., 131 Lexington St., Waltham, Mass.
Comparator & dial gages, length measuring devices

Ames Precision Machine Works, 131 Lexington St., Waltham, Mass.
Instrument lathes; hardness testers

Amglo Corp., 4234 Lincoln Ave., Chicago, Ill.
Gas discharge tubes; constant-speed d-c. timer motors
(See advertisement on page 38)

Amperite Corp., 561 Broadway, New York 12, N. Y.
Microphones

Ampex Electric Corp., 934 Charter St., Redwood City, Calif.
Magnetic tape recorder

Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.
Amplifiers

Amthor Testing Instrument Co., Inc., 48 Van Sinderen Ave., Brooklyn 7, N. Y.
Physical testing machines
(See advertisement on page 132)

Analysis Sales Co., 1827 Union Commerce Bldg., Cleveland 14, Ohio
Impact recorders

Anders Company, 5450 Wissahicken Ave., Philadel-
Instrument airdryers
phia, Pa.

Anderson, Arthur R., 110 Woodbury Ave., Springdale (Stamford), Conn.
Strain gages

Anderson Bros. Mfg. Co., 1910 Kishwaukee St., Rockford, Ill.
Balancing machines

Anetsberger Bros., Inc., Northbrook, Ind.
Temperature and humidity test chambers

Angle Computor Co., Inc., 1709 Standard Ave., Glendale 1, Calif.
Universal angle computers

Annin Company, 3500 Union Pacific Ave., Los Angeles 23, Calif.
Control valves

Annis Company, R. B., 1101 N. Delaware St., Indianapolis, Ind.
Permeameters, balancing machines

Antenna Research Lab., Inc., 797 Thomas Lane, Columbus 14, Ohio
Electronic instruments, amplifiers, computers

Applied Physics Corp., 362 W. Colorado St., Pasadena 1, Los Angeles, Calif.
Cary recording quartz spectrophotometer, Vibrating reed electrometer, color analyzers.

Applied Research Labs., 3717 Park Place, Montrose, Calif.
Spectromechanical testing apparatus including spectrographs projection comparators, densitometers & power source units for arc & spark analysis.
(See advertisement on page 123)

Applied Science Corp. of Princeton, P.O. Box 44, Princeton, N. J.
Research and development in electronics and physics

Arca Regulators, Inc., Upper Montclair, N. J.
Hydraulic & air operated controls

Aristo Import Co., Inc., 630 Fifth Ave., New York 20, N. Y.
Stop watches

Arma Corporation, 254 36th St., Brooklyn, N. Y.
Automatic inspection equipment

Arnold Engineering Co., P.O. Box G, Marengo, Ill.
Permanent magnets

Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford 7, Conn.
Magnetic, mercury & relay switches

Ashton Valve Company, 161 First St., Cambridge, Mass.
Pop safety & relief valves, pressure gage, gage testers & master pilot & master pressure gages

Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.
Automatic control instruments
(See advertisement on page 115)

Assembly Products, Inc., Main & Bell Sts., Chagrin Falls, Ohio
Electrical indicating instruments and accessories

Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.
Vibrotest insulation testing equipment. Special measuring & testing instruments of electrical nature.
(See advertisement on page 127)

Associated Valve & Engr. Co., 1150 W. Marquette Road, Chicago 21, Ill.
Automatic controllers; control valves; components

Atkomatic Valve Co., Inc., 545 Abbott St., Indianapolis, Ind.
(See advertisement on page 148)

Atlas Electric Devices Co., 361 West Superior St., Chicago 10, Ill.
Fade-Ometer, Weather-Ometer, Launder-Ometer

Atlas Exploration Co., 1911 West Alabama St., Houston 6, Texas
Geophysical instruments

Atlas Valve Co., 282 South St., Newark 5, N. J.
Regulator valves

Atomic Instrument Co., 84 Massachusetts Ave., Cambridge, Mass.
Radioactive detectors and electronic instruments
(See advertisement on page 64)

Audio Development Co., Transformer Div., 2833 13th Ave., Minneapolis 7, Minn.
Transformers, audio frequency equipment

Audio Instrument Co., 133 W. 14th St., New York 11, N. Y.
Audio-frequency equipment

Audio-Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Radio Test Instruments

Auth Electrical Specialty Co., Inc., 422 E. 53 St., New York 22, N. Y.
Signaling devices

Autocall Co., Shelby, Ohio
Electrical signaling, control & metering devices

Autoclave Engineers, Inc., P. O. Box 1027, Erie, Pa.
High pressure autoclaves, valves and thermocouples

Automatic Control Co., 1005 University Ave., St. Paul 4, Minn.
Circuit switches for automatic level, controls, automatic timing & sequence controllers

Automatic Electric Mfg. Co., Mankato, Minn.
Time switches & interval timers
Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago 7, Ill.
Telephone signaling & communication apparatus
(See advertisement on page 125)

Automatic Scale Co., Inc., 591 Hudson St., New York 14, N. Y.
Automatic scales

Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.
Solenoid operated valves & automatic electric control apparatus

Automatic Temperature Control Co., 5212 Pulaski Ave., Philadelphia 44, Pa.
Timers, time control and specialty engineering. Valves & valve controllers, various types of relays.

Automatic Valve Controller Co., Box 268, Tulsa 1, Okla.
Automatic valve control

Autotron Co., Danville, Ill.
Automatic inspection devices

B

Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh 8, Pa.
Industrial instruments

Badger Meter Mfg. Co., 2371 North 30th St., Milwaukee 10, Wis.
Liquid meters

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio
Metering & control equipment for power plants & industrial processes. Power plant instruments; boiler meter, meter combustion control operating directly from boiler meter, three-element feed water control, steam superheat control, desuperheating & pressure reducing control. Also metering & control equipment for sewage treatment, water supply & processing industries
(See advertisements on pages 49, 55, 56, 60, 63, 76, 91, 109)

Baird Associates, 33 University Road, Cambridge 38, Mass.
Specialized physical & optical instruments including complete line of spectrographic & x-ray diffraction equipment
(See advertisement on page 122)

Baker & Co., Inc., 113 Astor St., Newark 5, N. J.
Thermocouple wire; microchemical apparatus

Baker Compass Co., Melrose, Mass.
Compasses

Baldwin-Lima-Hamilton Corp., Testing Machine Dept., Eddystone, Pa.
Universal testing machines
(See advertisement on page 2)

Ballantine Labs., Inc., Boonton, N. J.
Artificial ears, electronic voltmeters, sound meters, vibration pickups, throat microphone, telephone receiver test equipment
(See advertisement on page 153)

Baltimore Biological Laboratory, 1640 Gorsuch Ave., Baltimore 18, Md.
Laboratory filling machines, pumps, etc.

Bar-Ray Products, Inc., 209 25th St., Brooklyn, N. Y.
X-ray equipment

Barber-Colman Co., Rockford, Ill.
Automatic controlling instruments for temperature, humidity, pressure, liquid level, moisture regain, motor-operated valves, solenoid valves, electric power units, damper controllers, voltage sensitive relays, associated switches & relays, fractional H. P. motors, geared motor units & hardness testers.

Barber Laboratories, Alfred W., 34-04 Francis Lewis Blvd., Flushing, L. I., N. Y.
Voltmeters
(See advertisement on page 155)

Barbour Stockwell Co., 205 Broadway, Cambridge, Mass.
Tachometers

Barksdale Valves, 1566 E. Slanson Ave., Los Angeles, Calif.
Control valves
(See advertisement on page 125)

Barnes Co., W. F. & John, 301 S. Water St., Rockford, Ill.
Automatic control equipment

Barnstead Still & Sterilizer Co. Inc., 2 Lanesville Terrace, Boston 31, Mass.
Water stills

Bartelt Engineering Co., 1214 Patridge Ave., Beloit, Wis.
Pedestal micrometers

Barr Instrument Co., Inc., 134-39 225 St., Springfield Gardens 13, N. Y.
Dimensional Gages

Barry Corp., 700 Pleasant St., Watertown 72, Mass.
Vibration mountings and isolators

Barton Instrument Co., 1429 S. Eastern Ave., Los Angeles 22, Calif.
Flowmeters & gages
(See advertisement on page 71)

Bastian-Blessing Co., 4201 W. Peterson St., Chicago 30, Ill.
Regulating valves

Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.
Optical instruments for industrial, scientific & educational use including microscopes, colorimeters, refractometers, photomicrographic & metallographic equipment, contour measuring projector, optical glass & special optical systems

Bayside Watch Tool Co., 211-12 Northern Blvd., Bayside, L. I., N. Y.
Machines, tools and dies for watch, clock and instrument industries

Beacon Gage Co., 11 River St., Wellesley, Mass.
Pressure gages
(See advertisement on page 78)

Beam Instruments Corp., 350 Fifth Ave., New York 1, N. Y.
Electronic instruments, cameras, testers

Bear Manufacturing Co., Rock Island, Ill.
Balancing machines

Beck Bros., 421 Sedgely Ave., Philadelphia 40, Pa.
Resistors

Beck Co., Harold, 3640 N. Second St., Philadelphia 40, Pa.
Pyrometer controllers

Becker Div., Christian; Torsion Balance Co., Clifton, N. J.
Precision balances & weights, including analytical, assay, magnetically damped, diamond, specific gravity, dairy druggists, textile.

Beckman, Inc., Arnold O., 1020 Mission St., So. Pasadena, Calif.
Scientific and industrial instruments; automatic gas analyzers and detectors; radioactivity detectors; dosemeters
(See advertisement on page 81)

Beckman Instruments, Inc., 830 Mission St., So. Pasadena, Calif.
pH instruments and electro-metric pH equipment for completely automatic indication, control and recording

Beckman & Whitley, San Carlos, Calif.
Anemometers, special cameras

Beede Electrical Instrument Co., Penacook, N. H.
Small electrical panel instruments

Bell & Howell Co., 7100 McCormick Rd., Chicago 45, Ill.
Motion picture equipment including cameras, projectors & accessories

Belco Glass, Inc., 413 N. 4 St., Vineland, N. J.

Berge, J. & H., 145 Hudson St., New York 13, N. Y.
Laboratory supplies

Bendix Aviation Corp., Eclipse-Pioneer Div., Teterboro, N. J.
(See advertisement on pages 97, 113)

Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood, Calif.
Airborne and ground instruments, industrial measuring, telemetering and remote control systems
(See advertisement on page 118)

Berger & Sons, Inc., C. L., 37 Williams St., Roxbury, Boston 19, Mass.
Surveying instruments

Berkeley Scientific Corp., 2200 Wright Ave., Richmond, Calif.
Radioactivity measurement instruments, & spectrometers
(See advertisement on page 67)

Berkshire Labs., 582 Lexington Rd., Concord, Mass.
Optical, electrical and electronic instruments

Beseler Co., Charles, 60 Badger Ave., Newark 8, N. J.
Optical projectors, galvanometer projectors, delineascopes

Best Scientific Glass App. Wks., 2449 N. Clybourn St., Chicago 14, Ill.

Bethlehem Apparatus Co., Front & Depot Sts., Hellertown, Pa.
Laboratory Apparatus, mercury cleaning machines

Betts & Betts Corp., 551 West 52nd St., New York 19, N. Y.
Multiple circuit timers, controls, time delay relays & motor driven & thermostatic interrupters

Biddle Co., James G., 1316 Arch St., Philadelphia, Pa.
Insulation testers, ground testers & ohmmeters, speed-measuring instruments, frequency meters, sliding-contact rheostats
(See advertisement on page 129)

Bidwell Instrument Co., 1007 Troy Place, N. W., Canton 3, Ohio
Microchemical laboratory apparatus; custom built research instruments.

Bin-Dictator Co., 14615 East Jefferson Ave., Detroit 15, Mich.
Automatic bin level indication & control

Birswanger & Co., 645-655 Union Ave., Memphis 1, Tenn.
Lenses, prisms & filters, Glass of every description

Bird Electronic Corp., 1800 E. 38th St., Cleveland 14, Ohio
Switches, wattmeters

Bird & Co., Richard H., 1 Spruce St., Waltham 54, Mass.
Jewel bearings
(See advertisement on page 49)

Black & Decker Mfg. Co., 715 Pennsylvania Ave., Towson, Md.
Truck scales

Black, Sivalls & Bryson, Inc., 7500 E. 12 St., Kansas City 3, Mo.
Automatic controllers, governors, valves
(See advertisements on pages 9, 10, 11, 12)

Black & Webster, Inc., 445 Watertown St., Newton 58, Mass.
Pellet presses, time study apparatus

Blake Co., Edward, 437 Cherry St., West Newton 65, Mass.
Dimensional gages

Bliley Electric Co., 200 Union Station Bldg., Erie, Pa.
Quartz piezo-electric crystals

Bliss & Co., Inc., John, 84 Pearl St., New York 4, N. Y.
Marine instruments

Block Mfg. Co., Fairy Rd., Parktour, Md.

Bock Machine Co., 3618 Colerain Ave., Cincinnati 23, Ohio
Erichsen sheet metal testing machine

Bodine Electric Co., 2254 W. Ohio St., Chicago 12, Ill.
Motors, all types of windings from 1/2000 to 1/6 hp. speed reducers & nonreducer motors

Boehmke Optical Co., 3737 Bird Road, Miami 33, Fla.
Precision optical manufacturers

Boekel & Co., Wm., 509-519 Vine St., Philadelphia 6, Pa.
Laboratory apparatus

Boeckeler Instrument Co., 31 E. Rillito St., Tucson, Ariz.
Precision levels, toolmaker's microscopes and time meters

Bogue Electric Mfg. Co., 75 Iowa Ave., Paterson 3, N. J.
Voltage and speed regulators; magnetic amplifiers and controllers; AC and DC motors and generators; switchboards
(See advertisement on page 37)

Bolsey Corp. of America, 118 E. 25th St., New York, N. Y.
Optical equipment, cameras and projectors

Boonton Radio Corp., P. O. Box 390, Boonton, N. J.
Radio test instruments
(See advertisement on page 111)

Booth Co., Arthur E., 4124 Beverly Blvd., Los Angeles 4, Calif.
Portable meter testers
(See advertisement on page 107)

Borg Corp., Geo. W., Equip. Div., 120 S. Main St., Janesville, Wis.
Potentiometer voltage dividers, slide wire rheostats

Borden Engineering Co., New Providence, N. J.
Ground resistance meters, pipe locators, signal generators

Boston Auto Gage Co., 70 West St., Pittsfield, Mass.
Liquid level gages and allied lines

Bostrom-Brady Mfg. Co., Stonewall & Bailey Sts., S.W., Atlanta, Ga.
Surveying instruments

Boulin Instrument Corp., 65 Madison Ave., New York 16, N. Y.
Chronometric hand tachometers, wound stroboscopes, electrical stroboscopes, speed indicators & portable & stationary tachometers

Bowen & Co., Inc., 4712 Bethesda Ave., Bethesda 14, Md.
Cement testers

Bowser, Inc., 1302 E. Creighton Ave., Fort Wayne 2, Ind.
Liquid meters

Bowser Technical Refrigeration, Terryville, Conn.
Testing cabinets, low temperature, high altitude, relative humidity

Boylston Steam Specialty Co., 116 W. Illinois St., Chicago 10, Ill
Regulating valves

Brabender Corp., 244 Saddle River Rd., Rochelle, Park, N. J.
Industrial measuring & control apparatus for plastic & viscous materials; semi-automatic moisture testers

Bradley Laboratories, Inc., 168 Columbus Ave., New Haven 10, Conn.
Photoelectric cells

Bradshaw Instruments Co., 42 Flatbush Ave., Brooklyn 17, N. Y.
Electrical instruments

Brady Co., W. H., 16 E. Spring St., Chippewa Falls, Wis.
Markers, labels, safety signs

Branson Instruments, Inc., 436 Fairfield Ave., Stamford, Conn.
Thickness gages, tube & sheet metal
(See advertisement on page 131)

Braun Corp., 2260 East 15th St., Los Angeles 21, Calif.
Chemicals & laboratory supplies

Braun-Knecht-Heimann Co., 1400 Sixteenth St., San Francisco, Calif.
Laboratory supplies

Bray Optical Co., 3445 W. 1st. St., Los Angeles 4, Calif.
Lenses, prisms & optical instruments

Breeze Corporation, 41 South 6th St., Newark 7, N. J.
Multiple connectors; radio ignition shielding

Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., 1225 Connecticut Ave., Bridgeport, Conn.
Metallic bellows and thermostats

Brigham Co., R. B., 624 Southard Ave., Toledo 2, Ohio
Photoelectric controls

Bristol Company, Waterbury 91, Conn.
Recording & automatic controlling instruments for pressure, vacuum, draft, absolute pressure, humidity, liquid level, flow, pH value, temperature (pyrometers & thermometers) & speed. Included are recording barometers, voltmeters, ammeters, wattmeters, dairy instruments, machine operation, motion & operation recorders, control valves, telemetering instruments, process cycle controllers, coordinated process control, time-temperature and time-pressure controllers, potentiometers, air operated & electric controllers & thermal converters. Dilatometers & combustible gas & vapor detectors
(See advertisements on pages 77, 85, 109, 110, 118, 137, 158)

Brodie Co., Inc., Ralph N., 61st & Lowell Sts., Oakland 8, Calif.
Positive displacement petroleum meters & accessories

Brooke Engineering Co., Inc., 4517 Wayne Ave., Philadelphia 44, Pa.
Electrically actuated pressure & flow controllers

Brookfield Engineering Laboratories, 2 Porter St., Stoughton, Mass.
Synchro-Lectric viscosimeter

Brooks Rotameter Co., Box 511, Lansdale, Pa.
Flowmeters

Brown Geophysical Co., 5300 Brownmay Rd., Houston 19, Tex.
Instruments for measuring earth's gravitational field

Brown Electro-Measurement Corp., 4635 S.E. Hawthorne Blvd., Portland 15, Calif.
Electrical instruments and components

Brown & Sharpe Mfg. Co., Providence 1, R. I.
Machine shop instruments

Browne-Morse Co., Muskegon, Mich.
Laboratory furniture

Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Frequency meters, signal generators, cathode-ray oscillographs

Bruning Co., Inc., Chas., 4754 Montrose St., Chicago 41, Ill.
Drawing & surveying instruments

Brunson Instrument Co., 1405 Walnut St., Kansas City 6, Mo.
Surveying instruments

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Magnetic direct writing oscillographs, a.c., d.c., and strain-gage amplifiers, uniformity, transient, and surface analyzers, deviation test bridges, sound level recorders, oscillators, and acoustical measurement instruments. "Hypersonic" equipment
(See advertisement on page 5)

Bryant Chucking Grinder Co., Springfield, Vt.
Screw thread gages

Buchanan Electrical Products Corp., 1290 Central Ave., Hillside, N. J.
Terminal blocks, terminals

Bud Radio, Inc., 2118 East 55th St., Cleveland, Ohio
Electronic components

Buffalo Meter Co., 2917 Main St., Buffalo 14, N. Y.
Liquid meters for measurement of cold water, hot water, oils, chemicals. Integrating registers, cumulative, setback, or predetermined control.
(See advertisement on page 91)

Buffalo Scale Co., 1200 Niagara St., Buffalo 13, N. Y.
Scales

Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.
Instruments for indicating, recording, controlling flow, liquid level, pressure, temperature, and weight

Bullard Co., E. D., 275 Eighth St., San Francisco 3, Calif.
Gas leak detectors

Bunnell Company, J. H., 81 Prospect St., Brooklyn, N. Y.
Relays & switches

Burgess Battery Co., Freeport, Ill.
Dry Batteries
(See advertisement on page 4)

Burke Electric Co., 8544 Grand River Ave., Detroit 4, Mich.
Fractional horsepower motors

Burke & James, Inc., 321 S. Wabash; Chicago 4, Ill.
Photographic equipment for research and laboratory departments
(See advertisement on page 101)

Burke, Louis, 41 John St., New York, N. Y.
Stop watches and chronometers

Burling Instrument Co., 5 Vose Ave., South Orange, N. J.
Temperature controls for laboratories, Industrial processes, furnaces & ovens. (-100° to 1400°F.) Standard tubes or special alloys & ranges.
(See advertisement on page 28)

Burlington Instrument Co., 214½ North 4th St., Burlington, Iowa
Electrical control apparatus

Burndy Engineering Co., 47 West Main St., Stamford, Conn.
Connectors, plugs and jacks

Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.
Scientific instruments & laboratory supplies

Burrows Equipment Co., 1316 Sherman Ave., Evanston, Ill.
Moisture testers

Burton Mfg. Co., 11201 W. Pico Blvd., Los Angeles 64, Calif.
Microscopic accessories & bank & turn indicators

B. W. Controller Corp., 2200 E. Maple Rd., Birmingham, Mich.
Floatless liquid level controls

C

Cadillac Gage Co., 20316 Hoover Road, Detroit 5, Mich.
Dimensional gages

Cady & Co., E. J., 134 N. LaSalle St., Chicago 2, Ill.
Non destructive testers for physical properties

Cal-Astro Optical Labs., 711 N. Lake St., Pasadena 6, Calif.
Optical instruments and components

Calculagraph Co., 300 Sussex St., Harrison, N. J.
Elapsed time indicator

Calibron Products, Inc., 51 Lakeside Ave., West Orange, N. J.
Special apparatus

Calidyne Co., 751 Main St., Winchester, Mass.
Accelerometers and vibration pickups

Callahan & Co., E. J., 14 W. Barre St., Baltimore 1, Md.
Laboratory supply house

Calta Glass Wks., 2158 Ogden Ave., Chicago 12, Ill.
Scientific glassware

Cambridge Instrument Co., Inc., 3732 Grand Central Terminal, New York 17, N. Y.
Scientific & industrial instruments

Cameron Surgical Specialty Co., 666 W. Division St., Chicago 10, Ill.
Surgical instruments

Campbell Co., J. A., 645 Wardlow Rd., Long Beach 7, Calif.
Thermometer wells & automatic controllers

Canadian Radium & Uranium Corp., 630 Fifth Ave., New York 20, N. Y.
Luminous, phosphorescent and flourescent paints

Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.
Multiple circuit connectors for instruments
(See advertisement on page 55)

Cargille Scientific, Inc., 118 Liberty St., New York 6, N. Y.
Chemical laboratory & photographic devices. Immersion liquids for inspecting glass & quartz

Carboloy Dept., General Electric Co., 11155 East 8 Mile St., Detroit 32, Mich.
Permanent magnets, magnetic alloys

Carter Parts Co., 213 Institute Place, Chicago 10, Ill.
Relays, resistors, rheostats & switches

Carver, Fred S., 345 Hudson St., New York 14, N. Y.
High pressure testing devices

Cash Co., A. W., P. O. Box 575, Decatur B, Ill.
Combustion control instruments

Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Scientific instruments & laboratory apparatus
(See advertisement on page 85)

Centralab Div., Globe Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.
Capacitors, rheostats, resistors & switches

Century Geophysical Corp., 1333 N. Utica Ave., Tulsa 6, Okla.
Geophysical instruments
(See advertisements on pages 14, 15)

Chace Co., W. M., 1600 Beard Ave., Detroit 9, Mich.
Thermostatic bimetals

Chandler & Stedman, 398 Newton St., Waltham 54, Mass.
Special laboratory apparatus

Charvos-Roos Corp., 185 Hackensack St., East Rutherford, N. J.
Drawing instruments

Chatillon & Sons, John, 85 Cliff St., New York 7, N. Y.
Iso-elastic springs
(See advertisement on page 180)

Chelsea Clock Company, 284 Everett Ave., Chelsea, Mass.
Clocks & clock movements
(See advertisement on page 161)

Chemical Rubber Co., 2310 Superior, East, Cleveland 14, Ohio
Laboratory supplies

Cherry-Channer Corp., 1488 Skokie Blvd., Highland Park, Ill.
Snap switches

Chicago Apparatus Co., 1735 No. Ashland Ave., Chicago 22, Ill.
Laboratory supplies

Chicago Condenser Co., 3255 W. Armitage Ave., Chicago 47, Ill.
Capacitors

Chicago Dial Indicator Co., 180 N. Wacker Dr., Chicago 6, Ill.
Machinist's dial indicators

Chicago Electric Tachometer Co., 111 Lake St., Madison, Ohio
Electric tachometers; portable tachometers, speed indicators

Chicago Electronic Engineering Co., 3223 W. Armitage Ave., Chicago 47, Ill.
Transformers

Chicago Industrial Inst. Co., 536 W. Elm St., Chicago 10, Ill.
Radio, electronic & industrial test equipment

Chicago Metal Hose Corp., 1309 S. 3rd Ave., Maywood, Ill.
Metal bellows

Chicago Surgical & Electrical Co., 324 W. Superior St., Chicago 10, Ill.
Laboratory supplies

SIGMUND COHN
SIGMUND COHN
NEW YORK
Galvanometer Suspension Ribbon

In Gold and Other Metals Or In Special Alloys

Remarkably free from "drift". Made to specified torsional values expressed in dyne-centimeters per radian twist per centimeter length. . . .

BARE WIRES drawn to .0004" diameter
RIBBON rolled as thin as .0001"

FINE WIRE and RIBBON OF CLOSER-THAN-COMMERCIAL TOLERANCES

CONTROL, WITHIN CLOSE LIMITS OF THE FOLLOWING CHARACTERISTICS: Size; Elongation; Tensile Strength; Torsional Properties; Electrical Resistance; Temperature Coefficient of Resistance; Weight per Unit Length; Purity . . . *Write for data and complete list of products.*

Since 1901

SIGMUND COHN CORP. • 44 GOLD ST., NEW YORK 7

need help

WITH YOUR SUB-ASSEMBLIES?

CHELSEA is equipped to deliver the complete *Precision Package . . .* or any part of it:

-ENGINEERING

-MANUFACTURING

-ASSEMBLING

Whether the application is electrical, mechanical or a combination of both, you'll find that Chelsea engineers have what it takes in terms of experience. Their know-how derives from designing and manufacturing parts to closest tolerances, creating Chelsea instruments of the keenest precision — for measuring time, computing intricate intervals, controlling, recording — *acting* higher in the stratosphere, deeper under the sea, than human control is able to go!

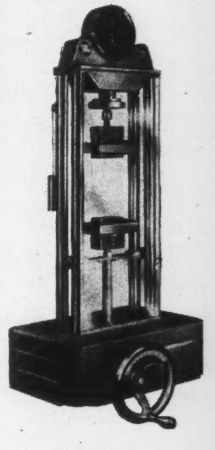
Whatever your assembly or sub-assembly problem, it is worth your while to consult Chelsea. A letter, telephone call, or telegram to Chelsea may solve your biggest problem!

Units that Chelsea has engineered and produced for many of America's leading industrialists include the following: temperature, flow, and water stage recorders; photographic remote controls, cylinder chart clocks, night watchmen's clocks, time clocks, and a wide variety of fully jewelled controls of highest precision.

Chelsea CLOCK CO.
71 Everett Avenue Chelsea, Mass.

DILLON PRECISION PRODUCTS

ILLUSTRATED BELOW ARE A FEW OF THE MORE POPULAR DILLON INSTRUMENTS WHICH ARE IN USE IN LEADING PLANTS, BY SCHOOLS AND UNIVERSITIES AND BY MOST GOVERNMENTAL DEPARTMENTS. ALL ARE AVAILABLE FOR *PROMPT* SHIPMENT.



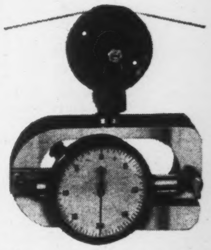
MODEL L UNIVERSAL TESTER

A high capacity universal tester for tensile, compression, transverse and shear work. Portable and easy to operate. For cloth, wire, springs, wood, metals, castings, plastics, etc.

Calibrated with elastic proving ring. Extreme accuracy. Available in 7 different capacities from as low as 0-250 lbs. up to 0-10,000 lbs. A 5" dia. or 10" dia. dial is optional.

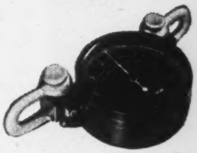
Handles standard round or flat specimens with ease and simplicity. Regular grips for flat specimens can be removed in seconds and replaced with any type of special gripping fixture.

Standard model is hand operated. Used on work bench. Can be supplied motorized to ASTM specs. if desired. America's *finest* low cost tester!



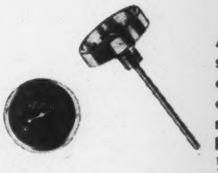
MECHANICAL PRESSURE GAUGE

This versatile instrument has unlimited application. For measuring mechanical, static or moving loads. Wide variety of adapting fixtures may be used with it. Illus. shows moving wire passing over pulley to indicate tension. 9 capacities. Jeweled dial indicator. From as low as 0-10 lbs. up to 0-5,000 lbs.



TRACTION DYNAMOMETER

Ideal for shop, laboratory or field use in determining static loads or tensile strains on objects that are too large or cumbersome for conventional testing machines. Reads directly in lbs. Thirteen different capacities from as low as 0-500 lbs. up to 0-100,000 lbs. More than 100 different uses.



DIAL THERMOMETERS

Accurate to 1% of the range over entire scale. Stainless steel construction. Large, easy-to-read dials in 2¼", 3" or 5" diameters. Wide variety of working ranges to suit every requirement in both Fah. and Centigrade. Provided with ½" or ¼" mounting nuts, and stem lengths from 3" up to 80". Special ranges or dial layouts to order.

Dillon
WEIGHT INDICATOR

WEIGHT INDICATOR

Fits directly on crane or hoist hook and weighs lightest or bulkiest objects with equal ease. 16" diameter dial provides fine divisional breakdown. Large eye-bolt at top and full swiveling hook at bottom. Extremely accurate. Calibrated with certified dead weights. Capacities from 0-250 lbs. up to 0-20,000 lbs. Fully dampened, has tare load compensation. Easily carried by one man yet extremely rugged. Effects real savings in time and money!

W. C. DILLON & CO., INC. 1421D S. CIRCLE AVE.
FOREST PARK, ILL.

Write for Illustrated Literature on Any or All of the Above

Chicago Transformer Corp., 3501 W. Addison St., Chicago 18, Ill.
Instrument & power transformers

Cincinnati Clock & Instrument Co., 1113 York St., Cincinnati 14, Ohio
Circuit breaker analyzer

Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati 14, Ohio
Time recorders

Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Electrical and electronic instruments and components
(See advertisement on page 46)

Circle Gauge Co., P. O. Box 2524, Hollywood 28, Calif.
Piston ring gages

Clare & Co., C. P., 4719 Sunnyside Ave., Jefferson Sta., Chicago, Ill.
Relays, electric counters & electro mechanical specialties

Clark Cooper Co., Palmyra, N. J.
Timers, alarms and controllers

Clark Instrument Co., Inc., 10202 Ford Road, Dearborn, Mich.
Hardness testers

Clark & Sons, Inc., Alvan, 58 Day St., West Somerville, Mass.
Optical & astronomical instruments

Clarke Insts. Div., National Electrical Machine Shops, Inc., 910 King St., Silver Spring, Md.
Electrical indicating instruments and accessories

Clarkstan Corp., 11923 W. Pico Blvd., Los Angeles 64, Calif.
Electronic equipment
(See advertisement on page 90)

Clarostat Mfg. Co., Inc., Dover, N. H.
Resistors

Clay-Adams Co., Inc., 141 East 25 St., New York 10, N. Y.
Angle & micro centrifuges, compact balances, analytical weights, microscope slides & cover glasses, glass & porcelain ink, tuning forks

Clebar Watch Co., 551 Fifth Ave., New York 17, N. Y.
Stop watches, timers & chronographs

Cleveland Fuel Equipment Co., 7316 Associate Ave., Cleveland 9, Ohio
Furnace controllers, pyrometers & gages

Clifford Mfg. Co. Div., Standard-Thomson Corp., 152 Grove St., Waltham 54, Mass.
Metallic bellows & diaphragms; thermostatic assemblies; packless valves

Climax Controls Div. see Black, Sivalls and Bryson, Inc.

Clippard Instrument Laboratory, Inc., 1125 Bank St., Cincinnati 14, Ohio
Electronic apparatus and electrical instruments

Clough-Brengle Co., 6014 Broadway, Chicago 40, Ill.
Electrical instruments, communication testing instruments

Cohn Corp., Sigmund, 44 Gold St., New York, N. Y.
Galvanometer suspension ribbon
(See advertisement on page 160)

Cole Co., H., 82 North High St., Columbus 15, Ohio
Surveying instruments

Cole Instrument Co., 1320 S. Grand Ave., Los Angeles 15, Calif.
Electrical instruments
(See advertisements on pages 104, 120, 154)

Coleman Instruments, Inc., 318 Madison St., Maywood, Ill.
Electrical measuring instruments for technical applications

Coleman Instrument & Mfg. Co., 716 Troost Ave., Tulsa 5, Okla.
Oscillographs

Collins Radio Co., Cedar Rapids, Iowa
Electronic apparatus

Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland 14, Ohio
Rheostats, instruments, shunts, switchboards & special electrical equipment

Combustion Control Corp., 77 Broadway, Cambridge, Mass.
Combustion controls

Commerce Pattern Foundry & Machine Co., 7450 Melville Ave., Detroit 17, Mich.
Balancing machines

Commercial Research Labs., Inc., 20 Bartlett St., Detroit 3, Mich.
Laboratory instruments for automotive, aircraft, railway & allied industries; air flow indicators, direct pressure & piezo-ray engine indicators, fuel flow indicators, magnetic gages, torsional vibration indicators (piezo-ray), recorders (torsiographs & recording instruments for car perfomance & riding comfort.

Communication Measurements Laboratory, 120 Greenwich St., New York 6, N. Y.
Testers, rectifiers, voltage regulators, communication measuring equipment

Compar Instrument Co., 455 Douglas Road, Holland, Mich.
Comparators, surface-finish microscopes and testers

Comtor Company, 83 Rumford Ave., Waltham 54, Mass.
Precision internal & external comparator-type diameter gages

Conant Laboratories, 6500 O St., Lincoln 5, Neb.
Dry disc rectifiers

Condenser Products Co., 7517 North Clark St., Chicago, Ill.
Capacitors

Conn, Ltd., C. G., Electronics Div., 1101 E. Beardsley Ave., Elkhart, Ind.
Stroboscopes

Connecticut Telephone & Electric Div., Great American Industries, Inc., Meriden, Connecticut
Electronic devices

Connelly Inc., 3154 S. California Ave., Chicago 8, Ill.
Gages & manometers, B T U indicator & H_2S tester

Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.
Valves, automatic controls
(See advertisements on pages 56, 58, 114, 148)

Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.
Geophysical instruments, mass spectrometers, vibration measuring equipment

Continental Electric Co., Geneva, Ill.
Photoelectric tubes & equipment

Continental Equipment Co., Coraopolis, Pa.
Valves

Control Corporation, 718 Central Ave., Minneapolis 14, Minn.
Automatic & remote control equipment

Control Products, Inc., 306 Sussex St., Harrison, N. J.
Thermostatic switches

Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill., Research Div., 1457 Diversey Pky., Chicago 14, Ill.
Electrical control devices, metal bellows, vapor meters & telephone protective & distributing apparatus, aircraft instrumentation, relays, pressure switches

Cook Research Laboratories, L. H., Box 696, Menlo Park, California
Precision testing instruments for oil industry, oil well cement testing equipment, combustible gas indicators, depth pressure recorders

Coors Porcelain Co., Golden, Colo.
Chemical & scientific porcelain

Corbin Screw Div., American Hardware Corp., New Britain, Conn.
Tachometers & speedometers

Cornell-Dubilier Electric Corp., Hamilton Blvd., So. Plainfield, New Jersey
Mica, dykanol, paper & wet & dry electrolytic capacitors

Corning Glass Works, Corning, N. Y.
Technical glassware

Coulter Electronics, 3023 W. Fulton Blvd., Chicago 12, Ill.
Amplifiers, microscopic particle and cell counters

Counter and Control Corp., 5227 W. Electric Ave., Milwaukee 14, Wis.
Circuit-control pre-set counters with automatic reset
(See advertisement on page 64)

Cramer Co., Inc., R. W. Centerbrook, Conn.
Interval timers, running time meters, time switches, signal control switches, time delay switches
(See advertisement on page 141)

Crawford Fitting Co., 884 E. 140 St., Cleveland 10, Ohio
Tubing and fittings
(See advertisement on page 145)

Crosby Steam Gage & Valve Co., 43 Kendrick St., Wrentham, Mass.
Safety & relief valves, gages, recorders, testers & steam engine indicators

Crown Industrial Products Co., 400 Borden Ave., Sycamore, Ill.

Crystal Glass Tube and Cylinder Co., 439 East 71 St., Chicago 19, Ill.
Heat resisting, precision hose and other forms of tubing
(See advertisement on page 84)

Crystal Research Labs., Inc., 29 Allyn St., Hartford 3, Conn.
Capicators, quartz products, filters, flats, frequency meters, signal generators, mirrors, oscillators, r-f. oscillators, vitreous silica, time interval apparatus, vibration pickups

Curtin & Co., W. H., P. O. Box 118, Houston, Tex.
Laboratory supplies

Curtis Development & Mfg. Co., 4524 W. Madison St., Chicago 24, Ill.
Thermostats

Curtis Labs., 2718 Griffith Park Blvd., Los Angeles 27, Calif.
Optical instruments and components; color separation cameras

Cuthbert Co., Inc., 322 South Third St., Minneapolis 15, Minn.
Scientific grain, seed and food testing equipment

Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wis.
Electric motor control, safety switches, motor driven valve operators, gas calorimeters, gas mixing & stabilizing control, resistors

Cyclohm Div., Howard Industries, 1215 State St., Racine, Wis.
Fractional-horsepower motors

Cyclotron Specialties Co., Morago 6, Calif.
Radioactivity equipment

D

Daco Machine & Tool Co., 202 Tillary Co., Brooklyn, N. Y.
Aviation and military instruments

Daigger & Co., A., 159 W. Kinzie St., Chicago 10, Ill.
Laboratory supplies

Dale Instruments Div., Electronic Development Co. 2002 N. 51st St., Omaha 4, Neb.
Electrical instruments

Daniel Orifice Fitting Co., 3346 Union Pacific Ave., Los Angeles, Calif.
Orifice flowmeters and fittings

Darley & Co., W. S., 2810 Washington Blvd., Chicago 12, Ill.
Pipe locaters

Davidson Mfg. Co., 5142 Alhambra Ave., Los Angeles, Calif.
Astronomical telescopes

Daven Co., 191 Central Ave., Newark 4, N. J.
Attenuators, calibrating equipment for electrical instruments & resistors

Davis Emergency Equipment Co., Inc., Davis Instruments Div., 80 Halleck St., Newark 4, N. J.
Inflammable gas alarms
(See advertisement on page 83)

Davis Regulator Co., 2541 So. Washtenaw Ave., Chicago 8, Ill.
Valves

Dearborn Gage Co., 22038 Beech St., Dearborn, Mich.
Chronium plated gage blocks

Dearborn Scientific Co., 1228 W. Kenzie St., Chicago 22, Ill.
Optical flats

Defender Inst. & Reg. Co., 815 Clark St., St. Louis, Mo.
Industrial instruments

De Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.
Photoelectric exposure meters, electrical, radio & photographic products

Delmhorst Instrument Co., 115 Cornelia St., Boonton, N. J.
Moisture detectors

Deming Indicator Co., 1016 Acorn Dr., Dayton 9, Ohio
Test indicators & dial indicators

Demuth Glass Works, Inc., Parkersburg, W. Va.

Denison Engineering Co., 1160 Dublin Rd., Columbus, Ohio
Presses

Denver Fire Clay Co., P. O. Box 5510, Denver 17, Col.
Specialized industrial control equipment for power plant & processing industries, laboratory specialties

Detect-O-Ray, 2622 N. Halsted St., Chicago 14, Ill.
Photoelectric counters

Derbyshire, Inc., F. W., 157 High St., Waltham 54, Mass.
Instrument lathes; micromills; chucks, etc.
(See advertisement on page 87)

Detecto Scales, Inc., 540 Park Ave., Brooklyn 5, N. Y.
Scales

Detectron Co., 5631 Coheunga Blvd., North Hollywood, Calif.
Leak and pipe detectors, radiation counters

De-Tec-Tronic Labs, Inc., 1711 Terra Cotta Place, Chicago 14, Ill.
Photoelectric instruments

Detroit Testing Machine Co., 9390 Grinnell Ave., Detroit 13, Mich.
Testing machines

De Vry Corporation, 1111 Armitage Ave., Chicago 14, Ill.
Scientific motion picture equipment & slide projectors

Dial Light Co. of America, Inc., 900 Broadway, New York 3, N. Y.
Dial lights

Diamond Power Specialty Corp., P. O. Box 415, Lancaster, Ohio
Industrial television

Dice Co., J. W., 1 Engle St., Englewood, N. J.
Gages, electrical instruments, non destructive inspection and testing equipment

Dickson Co., 7420 Woodlawn Ave., Chicago 19, Ill.
Furnace controls

Dietert Co., Harry W., 9330 Roselawn Ave., Detroit 4, Mich.
Sand testing equipment; immersion pyrometers, moisture testers, accessories for spectrographic laboratories
(See advertisement on page 128)

Dietzgen Co., Eugene, 2425 Sheffield Ave., Chicago 14, Ill.
Drafting & surveying instruments

Dillon & Co., Inc., W. C., 1421 S. Circle Ave., Forest Park, Ill.
Traction dynamometers, tensile machines, thermometers
(See advertisement on page 161)

Dimco-Gray Co., 207 E. 6 St., Dayton 2, Ohio
Timers and switches

Dirigo Compass & Instrument Co., Boeing Field, Seattle 8, Wash.

Distillation Products Industries, 755 Ridge Road West, Rochester 13, N. Y.
High vacuum pumps, low vapor pressure fluids & auxiliary equipment

Dittmore & Freimuth Co., 2517 E. Norwich St., Cudahy, Wis.
Electrical instruments, counters

DoAll Company, 254 N. Laurel, Des Plaines, Ill.
Gages, Brinnell hardness testers, precision tools

Doelcam Corp., 56 Elmwood St., Newton, Mass.
Precision instruments, gyroscopics, servomechanisms
(See advertisement on page 123)

Doerr Glass Co., Inc., 500 Peach St., Vineland, N. J.
Chemical glassware

Dollinger Corp., 11 Centre Park, Rochester 3, N. Y.
Instrument air filters

Doolittle Radio, Inc., 7421 Loomis Blvd., Chicago 36, Ill.
Frequency monitor

Dorothea Mechanisms, Gale, 81-01 Broadway, Elmhurst, L. I., N. Y.
Automatic controllers, motors, timers, switches

Dorr-Patterson Engineering Co., 3362 Wight Ave., Detroit 7, Mich.
Physical testing machines

Douglas Radio Labs., 176 Norfolk Ave., Boston 19, Mass.
Electrical and electronic instruments

Douglass Automatic Controls Co., 4505 E. Firestone Blvd., South Gate, Calif.
Boiler controls

Douthitt Corp., 650 W. Baltimore Ave., Detroit 2, Mich.
Process cameras & diaphragm control for cameras

Dow Corning Corp., Midland, Mich.
Silicone fluids and greases for high and low temperature lubrication of instruments, stop-cock grease, high vacuum grease, lens cement, liquid dielectrics, diffusion pump oils

Drafto Co., Cochranton, Pa.
Drafting machines

Drake Manufacturing Co., 1713 W. Hubbard St., Chicago 22, Ill.
Dial & signal lights
(See advertisement on page 104)

Ducommun Co., M., 580 Fifth Ave., New York, N. Y.
Coil-spring stopwatches

Du Mont Labs., Inc., Allen B., Clifton, N. J.
Cathode-ray oscillographs, cathode-ray tubes, associated electronic equipment, television control, studio & transmitting equipment

Duncan Electric Mfg. Co., Lafayette, Ind.
A-c. & d-c. watthour meters, service & switchboard types; portable test meters, appliance meters & instrument transformers

Durakool Inc., 1010 Main St., Elkhart, Ind.
Mercury switches

Durant Manufacturing Co., 1914 N. Buffum St., Milwaukee 1, Wis.
Counting & measuring machines

Dusenbery, John, 150 Pine St., Montclair, N. J.
Designers and builders of nautical instruments and special mechanical devices

Dwyer Mfg. Co., F. W., 317 S. Western Ave., Chicago 12, Ill.
Portable & stationary draft gages, CO_2 indicators & combustion testing sets
(See advertisements on pages 73, 90)

Dynamatic Corp., 3307 14th Ave., Kenosha, Wis.
Variable speed drives, torque measuring equipment

E

Eagle Signal Corp., 202 20th St., Moline, Ill.
Industrial control devices, traffic signal controllers & sign flashers

Eastern Industries, Inc., 296 Elm St., New Haven, Conn.
Laboratory pumps, stirrers & thermoregulators

Eastern Science Supply Co., 7-9 High St., Brookline, Mass.
Meteorological instruments

Eastern Specialty Co., 3617 N. 8th St., Philadelphia, Pa.
Testing equipment for checking & maintenance of all types of electricity meters such as watthour meters, demand instruments, etc. Special apparatus for load survey work.

Eastman Kodak Co., 343 State St., Rochester 4, N. Y.
Photographic equipment for laboratories, spectrographic, X-ray, etc.

Eastman Oil Well Survey Co., P. O. Box 408, Long Beach 1, Calif.
Underground surveying equipment

Eaton-Dikeman Co., Mt. Holly Springs, Pa.
Laboratory apparatus

Eberbach & Sons Co., Inc., 200 E. Liberty St., Ann Arbor, Mich.
Laboratory apparatus

Ebert Electronics Co., 185-09 Jamaica Ave., Hollis 7, N. Y.

Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia 44, Pa.
Relays & radio parts

Eck & Krebs, 2709 40th Ave., Long Island City, N. Y.

Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Aircraft electrical & mechanical accessories
(See advertisements on pages 97, 113)

Eder Instrument Co., 2293 N. Clybourn Ave., Chicago 14, Ill.
Pocket microscope

Edelmann & Co., E., 2332 Logan Blvd., Chicago 47, Ill.
Automotive test instruments

Edin Co., 207 Main St., Worcester, Mass.
Oscillographs and oscilloscopes
(See advertisement on page 103)

Edison, Inc., Thomas A., Instrument Div., West Orange, N. J.
Scaled-in-glass control devices, including thermostatic switches, fire detection thermostats, & timing relays. Hermetically sealed thermostatic valves. Special control equipment
(See advertisement on page 65)

Edwards, L. V., 32 Irving Place, Rockville Centre, N. Y.
Smoke-density instruments and alarms

Elcor, Inc., 1501 W. Congress St., Chicago 7, Ill.
Fractional H. P., geared, ungeared, synchronous, capacitor, and D. C. motors

Eitel-McCullough, Inc., San Bruno, Calif.
Electrical and electronic instruments and components

Eltzen Co., Louis C., 17 W. 60th St., New York 23, N. Y.
Extensometers

Electric Auto-Lite Co., Instrument & Gauge Div., Toledo 1, Ohio
Pressure & vacuum gages, speedometers, tachometers & thermometers

Electric Design & Mfg. Co., Burlington, Iowa
Electrical instruments

Electric Eye Equipment Co., Danville, Ill.
Automatic inspection devices

Electric Hotpack Co. Inc., Melrose St. at Cottman Ave., Philadelphia 35, Pa.
Designers and manufacturers of heat control and laboratory equipment
(See advertisement on page 40)

Electric Indicator Co., 21 Parker Ave., Stamford, Conn.
Synchronous motors, position indicators, level controls, signaling devices
(See advertisement on page 95)

Electric Regulator Corp., 50 Fay St., South Norwalk, Conn.
Current and frequency regulators

Electric Speed Indicator Co., 12234 Triskett Road, Cleveland 11, Ohio
Precision electric tachometers & remote position indicators

Electric Tachometer Corp., 2218 Vine St., Philadelphia 3, Pa.
Speed indicators & recorders, electric & mechanical counters

Electrical Facilities Inc., 4224 Holden St., Oakland 8, Calif.
Apparatus for electrical measuring & testing, including precision transformers, watthour meter and instrument transformer testing equipment; rectifier apparatus

Electrical Utilities Co., 2429 St. Vincent Ave., La Salle, Ill.

Electrimatic Div., Marsh Corp., J. P., 3501 Howard St., Skokie, Ill.
Automatic control valves & controls, regulating valves. Pressure, temperature & electrical actuation

Electrocon Corp., 219 Sunrise Highway West, Freeport, N. Y.
Vibration measuring instruments

Electro Engineering Products Co., 609 West Lake St., Chicago 10, Ill.
Instrument and servomechanism motors; signal generators, HF apparatus

Electro-Mec Laboratory, 225 Broadway, New York 7, N. Y.
Electrical and electronic components

Electro-Mechanical Instrument Co., 812 Chestnut St., Perkasse, Pa.
Electrical instruments

Electro-Mechanical Research, Inc., 64 Main St., Ridgefield, Conn.
Electrical and electronic instruments and components

Electro Mechano Co., 261 E. Erie St., Milwaukee 2, Wis.
Tachometers, precision drill press
(See advertisement on page 126)

Electro-Medical Laboratory, Inc., South Woodstock, Vt.
Neurological & Allied medical instruments & general electronic apparatus
(See advertisement on page 53)

Electro-Physics Co., Box 136, G.P.O., New York 1, N. Y.

Electro Products Laboratories, Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.
Battery eliminators & rectified A. C. devices
(See advertisement on page 107)

Electro-Tech Equipment Co., 309 Canal St., New
Ammeters, voltmeters, power analyzers, bridges
York 13, N. Y.

Electronic Apparatus Corp., 116 E. Jackson Blvd., Elkhart, Ind.
Mercury relays and switches

Electronic Associates, Inc., 61 Brighton Ave., Long Branch, N. J.
Aircraft and electrical instruments

Electronic Controls, Inc., 4521 Chestnut St., Philadelphia 39, Pa.
Electronic controllers and timers for counting, lighting, etc.

Electronic Development Lab., 2655 W. 19th St., Chicago 8, Ill.
Electronic apparatus

Electronic Engineering Associates, Ltd., 778 El Camino Rd., San Carlos, Calif.
Dynamic pressure measuring equipment
(See advertisement on page 50)

Electronic Instrument Co., 276 Newport St., Brooklyn 12, N. Y.
Electrical and electronic instruments

Electronic Mfg. Co., 140 S. Second St., Harrisburg, Pa.
Oscillators, voltmeters

Electronic Products Co., 5330 E. Olympic Blvd., Los Angeles 22, Calif.
Glass instruments & apparatus

Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia, Pa.
Cathode ray oscillographs

Electrons, Inc., 127 Sussex Ave., Newark 4, N. J.
Gas-filled & grid-control rectifier tubes

Electyme Motor Products Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Clocks and timers

Elematic Equipment Corp., 1150 West Marquette St., Chicago 21, Ill.
Pyrometers

Elgin National Watch Co., Elgin, Ill., Industrial Products Dev., Aurora, Ill.
Watches, clocks, gages, gaging fixtures and micrometers

Ellison Draft Gage Co., 214 West Kenzie St., Chicago 10, Ill.
Manometers, draft gages, orsats

El-Tronics, Inc., 2647 N. Howard St., Philadelphia 33, Pa.
Electrical instruments, nuclear measuring devices

Emerson Apparatus Co., 171 Tremont St., Melrose, Mass.
Calorimeters

Emery Company, A. H., Pine St., New Canaan, Conn.
Pressure gages and testing machines
(See advertisement on page 133)

Emmett Machine & Mfg. Co., 2249 Fourteenth St., S. W., Akron 14, Ohio
Automatic controllers, timer and control valves
(See advertisement on page 27)

Empire Devices, Inc., 38-25 Bell Blvd., Bayside, N. Y.
High frequency apparatus

Engel, Inc., H. C. M., P. O. Box 233, Sidney, N. Y.
Small drills, small turned parts, millstones in sapphire and block grinding discs

Engelhard, Inc., Charles 900 Passaic Ave., East Newark, N. J.
Industrial instruments

Engineering Laboratories, Inc., 602 E. 4th St., Tulsa 1, Okla.
Seismic exploration equipment, vibration detectors, petroleum engineering devices, signaling equipment

Engineering Research & Development Co., P. O. Box 166, Hinsdale, Ill.
Precision instruments custom built
(See advertisement on page 44)
Engineering Research Associates, Inc., 1902 West Minnehaha Ave., St. Paul 4, Minn.

Engineers Specialty Div., Universal Engraving & Colorplate Co., 980 Elliott St., Buffalo 9, N. Y.
Optical comparators

Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.
Microscopes, surveying instruments, photoelectric color analyzers, optical flats and components

Eppley Laboratory Inc., 12 Sheffield Ave., Newport, R. I.
Thermopiles, pyrheliometers & standard cells for both industrial & laboratory use
(See advertisements on inside front cover and page 51)

Equipoise Controls, 100 Stevens Ave., Mount Vernon, N. Y.
Thermometers and tachometers

Erb & Gray, 854 S. Figueroa St., Los Angeles 7, Calif.
Optical, mechanical and electrical instruments
(See advertisement on page 93)

Erickson Specialty Co., 10 Cayuga St., Cohoes, N. Y.
Solenoid valves

Erie Resistor Corp., 644 West 12th St., Erie, Pa.
High frequency & molded resistors

E & S Optical Co., 911 Willow Ave., Hoboken, N. J.
Optical components

Ess Instrument Co., 96 S. Washington Ave., Bergenfield, N. J.
Industrial electronic instruments, photoelectric for smoke, flame, turbidity, color. Specific gravity indicators, recorders and controllers

Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis 6, Ind.
Graphic recording & contract-making electrical instruments, time, speed, condensate purity, pressure & vacuum recorders, telemeters & portable current transformers

Eureka X-Ray Tube Corp., 3240 N. Kilpatrick Ave., Chicago, Ill.
X-ray tubes

Evaporated Metal Films Co., Ithaca, N. Y.
(See advertisement on page 100)

Ever Ready Thermometer Co., 1118 Bedford Ave., Brooklyn 5, N. Y.
Calorimeters, thermometers

Everson Mfg. Co., 214 W. Huron St., Chicago 10, Ill.
Chemical feeders

Exact Weight Scale Co., 944 West 5th Ave., Columbus 8, Ohio
Over-and-under weight scales & indicators for industrial purposes

F

Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.
Scales

Fairchild Camera & Inst. Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.
Instrument motors, servo-motors,, navigational instruments, oscilloscope- and X-ray recording cameras.

Fairchild Recording Equipment Corp., 154 St. & 7th Ave., Whitestone, N. Y.
Magnetic tape recorder

Falstrom Co., 92 Falstrom Ct., Passaic, N. J.
Steel instrument panels, panel board assemblies, cubicles, totally enclosed weather & vermin proof instrument enclosures & steel cabinets.
(See advertisement on page 25)

Farnsworth Television & Radio, Fort Wayne, Ind.
Industrial television systems

Farrand Optical Co., Inc., Bronx Blvd. and E. 238 St., New York 66, N. Y.
Scientific instruments

Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.
Calipers for checking roll diameters & gear tooth comparators

Farris Engineering Corp., 436 Commercial Ave., Palisades Park, N. J.
Safety and relief valves; naval and aircraft regulators; and hydraulic remote controls
(See advertisement on page 149)

Farris-Stacon Corp., Palisades Park, N. J.
Automatic controllers, valves
(See advertisement on page 63)
Fassett Co., Inc., C. M., W. 21 Main Ave., Spokane 8, Wash.
Laboratory supplies

Fast & Co., John E., 3105 N. Crawford St., Chicago 41, Ill.
Capacitors

Fecker, J. W., 2016 Perryville Ave., Pittsburgh 14, Pa.
Astronomical instruments

Federal Anti- Capacity Switch Corp., 1200 Niagara St., Buffalo, N. Y.
Anti-capacity switches

Federal Classifier Systems, Inc., 127 N. Dearborn St., Chicago 2, Ill.
Particle size classifiers

Federal Instrument Co., 14-02 Broadway, Long Island City 2,N.Y.
Resistors

Federal Mfg. & Eng. Corp., 211 Steuben St., Brooklyn 5, N. Y.
Microscopes

Federal Products Corp., 1144 Eddy St., Providence 1, R. I.
Precision measuring instruments
(See advertisement on page 72)

Federal Telephone and Radio Corp., 100 Kingsland Road, Clifton, N. J.
Radio transmitting and direction finding equipment, transmitting tubes, field intensity meters

Feiler Engineering Co., 8026 N. Monticello Ave., Skokie, Ill.
Electrical Instruments

Fellows Gear Shaper Co., Springfield, Vt.
Gear checking machines & involute measuring machines

Fenwal, Inc., 3 Main St., Ashland, Mass.
Industrial thermostats
(See advertisement on page 26)

Ferguson Co., 814 Ridgely St., Baltimore 30, Md.
Laboratory supply house

Ferner Co., R. Y., 110 Pleasant St., Malden, Mass.
Precision instruments

Ferrier Engineering, 24 Benton St., Springfield, Mass.
Special instruments; test stands for automatic and diesel industries
(See advertisement on page 127)

Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Electrical instruments

Ferris Instrument Corp., Boonton, N. J.
Laboratory & production testing equipment, radio noise & field strength meters & special electrical instruments

Fidelity Machine Co., 3906 Frankfort Ave., Philadelphia, Pa.
Abrasion testers

Field Electrical Instrument Co., 8 North Manheim Blvd., New Paltz, N. Y.
Electrical instruments

Fielden Instrument Corp., 2920 N. 4th St., Philadelphia 33, Pa.
Automatic controllers, electrical instruments

Fischer & Porter Co., 37 County Line Road, Hatboro, Pa.
Rotameters, sight flow meters, automatic flow controllers, precision optical cells, precision bore glass tubing & special precision glass apparatus.

Fish-Schurman Corp., 68 Portman Rd., New Rochelle, N. Y.
Scientific instruments, optical, technical & scientific glass & porcelain
(See advertisement on page 98)

Fisher Governor Co., Marshalltown, Iowa
Motor control valves & regulators

Fisher-Pierce Co., 70 Ceylon St., Boston 21, Mass.
Photoelectric controls, relays, timers

Fisher Research Laboratory, Box 640, Palo Alto, Calif.
Leak detector & pipe finder. Electronic equipment
(See advertisement on page 104)

Fisher Scientific Co., 711 Forbes St., Pittsburgh 19, Pa.
Standard & special equipment & instruments for chemical, biological & metallurgical laboratories

Flader, Inc., Fredric, 583 Division St., North Tonawanda, N. Y.
Aircraft Instruments

Fleischauer & Son, F., 89-36 187 Place, Hollis, L. I., N. Y.
Instrument makers

Fillo Sales & Engineering Co., 4401 Chouteau Ave., St. Louis 10, Mo.
Automatic control and combustion safety devices

Flexible Valve Corp., 400 Commercial Ave., Palisades Park, N. J.
Automatic valves
(See advertisement on page 148)

Flight Research Engineering Corp., P. O. Box 1-F, Richmond 1, Va.
Servomechanisms and automatic control systems

Fonda Gage Co., 53 Daly St., Stamford, Conn.
Gage blocks

Food Technology, Inc., 5903 NW Highway, Chicago 31, Ill.
Temperature and humidity chambers, testing apparatus
(See advertisement on page 53)

Ford Engineering Co., 134 N. Second Ave., Upland, Calif.
Voltage dividers
(See advertisement on page 106)

Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.
Airbourne and ground instruments, automatic controllers, servomechanisms

Ford Regulator Valve Co., 403 Broome St., New York 13, N. Y.
Regulating valves

Foster Engineering Co., 835 Lehigh Ave., Union, N. J.
Control valves

Foxboro Co., Foxboro, Mass.
Indicating, recording & controlling instruments for pressure, temperature, humidity, level & flow
(See advertisement on page 23)

Fox Valley Instrument Co., Ingelside, Ill.
Industrial and automatic service instruments

Fraser Development Laboratory, P. O. Box 73, Huntington Station, N. Y.
Fluxometer for measuring magnetic flux in gauss

Freas Glass Works, Francis L., 146 E. 9th St., Conshohocken, Pa.
Hydrometers, thermometers & glass instruments
(See advertisement on page 136)

Fredericks Co., George E., Bethayres, Pa.
Glass instruments & apparatus

Freed Transformer Company, 1718 Weirfield St., Brooklyn 27, N. Y.
Transformers

Frick Co., Inc., Waynesboro, Pa.
Float valve controls & electric controls, refrigerating & air conditioning machinery

Friez Instrument Div., Bendix Aviation Corp., Towson 4, Md.
Temperature & humidity controls, gas & stoker controls, damper motors, electrical relays, temperature & humidity indicators & recorders, psychrometers, draft gages, anemometers, CO_2 analyzers

Fuess, Inc., R., 39 West 60th St., New York 23, N. Y.
Scientific instruments

Fuel Watchman, 77-29 138 St., Flushing, L. I., N. Y.

Fulcrum Oil Company, Franklin, Pa.
Instrument oils

Fuller Co., 110 Bridge St., Catasauqua, Pa.
Bulk material level controllers

Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Knoxville 4, Tenn.
Temperature & pressure regulators, sylphon bellows; thermostat assemblies; diesel controls; automobile thermostats; air conditioning controls

Furnas Electric Co., 300 McKee St., Batavia, Ill.
Pressure controls

Furst Electronics, 14a S. Jefferson St., Chicago 6, Ill.
Electronic instruments

G

Gadgets, Inc., 3629 N. Dixie Drive, Dayton 4, Ohio
Airbourne and ground instruments, testing chambers

Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.
Measuring instruments including toolmaker microscopes, micrometer slides, micrometer microscopes, comparators, interferometers, spherometers, microscopes & telescopes for observation & inspection; time recording devices including chronographs & special devices; dividing machines for engraving linear & circular scales; goniometers; spectroscopic equipment & accessories
(See advertisement on page 165)

Gallien, R. P., 220 W. 5 St., Los Angeles 13, Calif.
Instrument lathes & tools

Gamma Instrument Co., Inc., P. O. Box 532, Great Neck, L. I., N. Y.
Micrographic cameras, micromanipulators

Gardner Laboratory, Inc., Henry A., 4723 Elm St., Bethesda 14, Md.
Scientific instruments, automatic inspection devices

Gas Appliance Specialties Co., 32-37 56th St., Woodside, New York, N. Y.
Gas regulators

Gaunt Industries, 827 Irving Park Road, Chicago 13, Ill.
Precision tools, lubrication devices for fine mechanisms

Gaertner

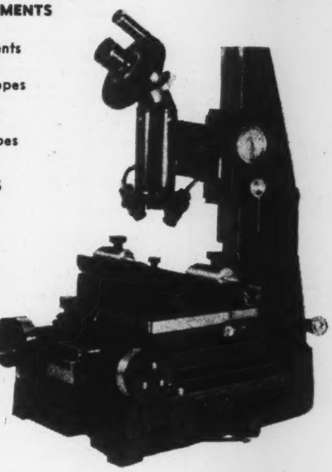
PRECISION OPTICAL AND MEASURING INSTRUMENTS

MEASURING INSTRUMENTS
Cathetometers
Creep Test Instruments
Comparators
Micrometer Microscopes
Micrometer Slides
Standard Scales
Toolmaker Microscopes

DIVIDING MACHINES
Circular
Linear
Manual
Automatic

INTERFEROMETERS
Michelson
Fabry Perot
Thermal Expansion

POLARIZING
Compensators
Polarimeters
Polariscopes



TEST INSTRUMENTS
Optical Benches
Spherometers
Spectrometers
Microscopes
Telescopes
Refractometers

SPECTROGRAPHS
Infrared
Quartz
Raman
Spectroscopes
Monochromators

PHOTOMETERS
Martens
Spectrophotometers
Microdensitometers

MISCELLANEOUS
Chronographs
Laboratory Supports
Precision Ruling

Write for Survey of Gaertner Instruments and Index to Current Literature.

THE GAERTNER SCIENTIFIC CORP.
1208 Wrightwood Ave. Chicago 14, U.S.A.

Geier & Bluhm, Inc., 607 River St., Troy, N. Y.
Mechanical devices & spirit level vials
(See advertisement on page 88)

Gelber, Samuel S., 162 N. Clinton St., Chicago 6, Ill.
Balancing machines

Genales, Andrew, 29 Second Ave., Nyack, N. Y.
Toolroom test indicators

General Biological Supply House, Inc., 761 East 69th Pl., Chicago 37, Ill.
Biological laboratory supplies

General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Switches, cement tester, and spark plug tester

General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
Electrical switches

General Controls Co., 801 Allen Ave., Glendale 1, Calif.
Pressure, temperature & flow control valves
(See advertisement on page 6)

General Electric Co., 1 River Rd., Schenectady 5, N. Y.
Electrical instruments & meters
(See advertisement on page 20)

General Electric Co., 1285 Boston Ave., Bridgeport 2, Conn.
Rectifiers & switches

General Electric Co., Carboloy Dept., 11177 E. 8 Mile Dr., Detroit 32, Mich.
Permanent magnets, magnetic alloys

General Electric Co., Chemical Dept., 1 Plastics Ave., Pittsfield, Mass.
Magnets and instrument oils

General Electric Co., Electronic Dept., 1001 Wolf St., Syracuse, N. Y.
Electronic equipment

General Electric Co., Lamp Dept., Nela Park, Cleveland 12, Ohio
Lighting sources

General Electric X-Ray Corp., 4855 W. Electric Ave., Milwaukee 14, Wis.
Medical, dental & industrial X-ray apparatus, accessories & supplies

General Physical Laboratory, 509 Fifth Ave., New York 17, N. Y.
Special light sources

General Power Plant Corp., 381 Fourth Ave., New York 16, N. Y.
Furnace controls

General Precision Lab., Inc., Pleasantville, N. Y.
Electrical and electronic instruments, testing equipment

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Radio & electrical measuring instruments for laboratory & industrial use; stroboscopes noise measuring equipment, measuring & test equipment for electrical communication systems

General Regulator Corp., 165 Broadway, New York 6, N. Y.
Combustion, draft, liquid level & pressure controls

General Scientific Corp., 5151 West 65 St., Chicago 38, Ill.
Lenses & photoelectric cells

General Test Equipment Co., 38 Argyle Park, Buffalo 9, N. Y.
Pen size radio signal source, also special apparatus

Genisco Inc., 2233 Federal Ave., Los Angeles 64, Calif.
Testers for aviation instruments, guided missile instrumentation, components, digital-output converters and comparators
(See advertisement on page 42)

Geophysical Instrument, Div. Georator Corp., Key Blvd. & Nash St., Arlington 9, Va.
Instruments & accessories for prospecting for oil, minerals, water, bedrock; also equipment for making measurements in wells, radioactivity instruments

Geotechnical Corp., 3712 Haggar Drive, Dallas, Texas
Geophysical instruments

Gertsch Products, Inc., 11846 Mississippi Ave., Los Angeles 25, Calif.
Frequency standards, frequency meters, filters

G. & G. Precision Works, Inc., 5-33 Forty-eighth Ave., Long Island City 1, N. Y.
Mechanical optical & electrical precision instruments

Giannini & Co., G. M., 285 West Colorado St., Pasadena 1, Calif.
Aircraft instruments
(See advertisement on page 106)

Gilbert & Barker Mfg. Co., West Springfield, Mass.
Instrument housings

FRED C. HENSON
COMPANY

specializing in

CUSTOM BUILT
INSTRUMENTS

★

3311 E. COLORADO ST.
PASADENA 8, CALIFORNIA

ESTABLISHED 1925

Gilman Scientific Instrument Co., 527 S. Fair Ave., Pasadena 1, Calif.
Seismographs

Gilmore, E. R., Box 5718, Homewood Sta., Pittsburgh 8, Pa.
Gas leak stethoscopes

Gisholt Machine Co., Madison 3, Wis.
Static & dynamic balancing machines

Glass Engineering Laboratories, 601 O'Neill Ave., Belmont, Calif.
Laboratory apparatus; ultra-speed centrifuges

Gleason-Avery, Inc., Auburn, N. Y.
Furnace controls

Globe Industries, Inc., 125 Sunrise Place, Dayton, O.
Aircraft instrument testing equipment, aircraft interval timing istruments, aircraft photo equipment, automatic control instruments
Globe Phone Mfg. Corp., Reading, Mass.
Pipe locating equipment, leaky valve locators, hearing aids, secret phone or listening equipment for government investigating agencies

Globe Tool & Engg. Co., 410 Davis Ave., Dayton 3, Ohio
Dynamic balancing equipment

Glogau & Co., Inc., 1912 W. Birchwood, Chicago 26, Ill.
Calipers

G-M Laboratories, Inc., 4326 N. Knox, Cihcago 41, Ill.
Galvanometers and galvanometer relays

G. M. Manufacturing Co., 50 West 3 St., New York, N. Y.
Thermometers, hydrometers, psychrometers, hygrometers

Goerz American Optical Co., C. P., 317 East 34th St., New York 16, N. Y.
Photographic lenses, optical prisms & flats, and other optical units to specification

Gogan Machine Corp., 1440 E. 55 St., Cleveland 3, Ohio
Automatic hardness testers

Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1., Calif.
Surveying instruments, pipe locators, leak detectors

Goodrich Co., B. F., 450 South Main St., Akron, Ohio
Vibration absorbers

Gordon Co., Claud C., 3000 S. Wallace St., Chicago 16, Ill.
Pyrometers, metallurgical testing machines, thermocouples, thermocouple wire, lead wire, insulators

Gordon Machine & Tool Co., Inc., 1910 W. Atlantic St., Philadelphia 40, Pa.
Thermocouples; thermocouple wells

Gorrell & Gorrell, Haworth, N. J.
Equipment for biological & psychological work
(See advertisement on page 140)

Gotham Instruments Div., American Machine & Metals, Inc., Dept. 2, 233 Broadway, New York 12, N. Y.
Indicating dial & recording thermometers
(See advertisement on page 29)

Gotham Scientific Co., 106 Water St., New York 5, N. Y.
Laboratory supplies

Gothard Mfg. Co., 2110 Clear Lake Ave., Springfield, Ill.
Dynamotors, inverters, converters, pulse generators

Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J.
Thermal conductivity gas analyzers & gas analysis cells
(See advertisement on page 81)

Graflax Corp., 154 Claressa St., Rochester, N. Y.
Scientific cameras

Graham-Mintel Instrument Co., 735 Carnegie Ave., Cleveland 15, Ohio
Precision measuring instruments

Gramer-Transformer Corp., 2734 N. Pulaski Rd., Chicago 39, Ill.
Transformers: instrument, power, adjustable, phasing, regulating
(See advertisement on page 142)

Gray Instrument Co., 64½ W. Johnson St., Philadelphia 44, Pa.
Scientific instruments

Grayhill, Inc., 4524 W. Madison St., Chicago 24, Ill.
Switches

Green, Henry J., 1191 Bedford Ave., Brooklyn 16, N. Y.
Meteorological instruments

Green Instrument Co., 383 Putnam Ave., Cambridge, Mass.
Engraving machines
(See advertisement on page 69)

Greene Bros., Inc., 1810 Griffin St., Dallas 2, Texas
Laboratory supplies

Greenfield Tap & Die Corp., Greenfield, Mass.
Machine shop gages

Greiner, Inc., Emil, 20-26 N. Moore St., New York 13, N. Y.
Laboratory supplies

Griebel Co., E., 8 Wayne St., Carbondale, Pa.
Thermometers, hydrometers, chemical & laboratory glassware

Grieve-Henary Co., Inc., 1101 N. Paulina St., Chicago 22, Ill.
Laboratory ovens

Griner Co., A. J., 1827 McGee St., Kansas City 8, Mo.
Laboratory supplies

Griswold Mfg. Co., F. T., Lancaster Ave., Wayne, Pa.

Grove Regulator Co., 1190 67th St., Oakland 8, Calif.
Pump governors, pressure reducing & back pressure regulators for gas or liquid pressures to 6000 lbs.

Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.
A-c and d-c relays
(See advertisement on page 117)

Gulton Mfg Corp., 212 Durham Ave., Metuchen, N. J.
Accelerometers, ballistocardiographs, precision capacitors

Gump Co., B. F., 1325 So. Cicero St., Chicago 50, Ill.

Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Surveying & allied engineering instruments, paper testing & aeronautical navigation instruments & standard weights & measures

Gustafson Mfg. Co., G. D., 5328 N. Kedzie St., Chicago 25, Ill.
Instrument tools
(See advertisement on page 142)

G-V Controls Inc., 28 Hollywood Plaza, East Orange, N. J.
Relays, switches

H

Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa.
Combustion control equipment; flow meters, draft & pressure gages for law pressure gas & air measurements: recording, indicating & integrating in any combination
(See advertisement on page 3)

Haines Designed Products Corp., 117 N. Findlay St., Dayton 3, Ohio
Ultracentrifuges

Halldorson Co., 4500 Ravenswood Ave., Chicago 40, Ill.
Transformers: instrument, testing, adjustable, regulating

Halliburton Oil Well Cementing Co., Duncan, Okla.
Oil well surveying instruments

Hamiton Mfg. Co., Two Rivers, Wis.
Laboratory furniture

Hamilton Watch Co., Lancaster, Pa.
Chronometers & watches

Hammel-Dahl Co., 243 Richmond St., Providence, R. I.
Automatic control valves

Hand & Sons Co., John E., Atlantic & Washington Aves., Haddonfield, N. J.
Navigational instruments

Hankison Corporation, 1501 Beaver Ave., Pittsburgh 33, Pa.
Filter for instrument air

Hanovia Chemical & Mfg. Co., 90 Chestnut St., Newark 5, N. J.
Quartz mercury arc lamps

Hansen Co., Wm., 165 Silverbrook Ave., Niles, Mich.
Timers and clocks

Hanson Mfg. Co., Inc., Princeton, Ind.
Electric Motors, servomechanism components, clock movements

Hardwick, Hindle, Inc., 40 Herman St., Newark 5, N. J.
Resistors

Hart Mfg. Co., R. E., 635 S. Main St., Ann Arbor, Mich.
Production counters

Hart Moisture Gauges, see Kaydel Moisture Gauges

Hart Moisture Meters, Grand Central Terminal, New York, N. Y.
Moisture testers

Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Electronic apparatus

Harvey-Wells Electronics, Inc. Southbridge, Mass.
Aircraft navigational instruments

Hasler-Tel Co., 30 Vesey St., New York 7, N. Y.
Speed indicators, portable, chronometric

Hass Brothers Instrument Co., 6236 Ritchie Rd., Washington 19, D. C.
Barometers, altimeters, manometers

Hastings Instrument Co., P. O. Box 1275, Hampton, Va.
Consulting instrument engineers, special developments

Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Instruments & apparatus for electrical & mechanical measurements & control

Hawk Tool Engineering Co., Inc., Clarkston, Mich.
Controllers & testing devices

Haydon Co., A. W., 232 N. Elm St., Waterbury 32, Conn.
Relays and timers
(See advertisement on page 43)

Haydon Manufacturing Co., Torrington, Conn.
Synchronous Motors, automatic timers

Hayes Scientific Appliances, 202 N. Broadway, Urbana, Ill.
Scientific instruments

Hays Corp., P. O. Box 299, Michigan City, Ind.
Combustion instruments & automatic combustion controls
(See advertisements on pages 61, 81, 83)

Hayward Scientific Glass Co., 217 Magnolia St., Whittier, Calif.
Optical instruments and components

H-B Instrument Co., Inc., 2633 Trenton Ave., Philadelphia 25, Pa.
Thermometers & hydrometers, remote control equipment

HD Electric Co., 760 Osterman Ave., Deerfield, Ill.
Split core ammeters, demand meters

Hebler Co., W. O., Central at Long Ave., Hillside, N. J.
Electrical gas analyzers

Heil Corp., 210-214 S. 4 St., St. Louis 2, Mo.
Laboratory supplies

Heiland Research Corp., 130 E. 5th Ave., Denver 9, Colo.
Geophysical instruments, photoflash synchronizers, gas detectors, oscillographs, strain gages, vibration detectors, recording cameras & industrial instruments.
(See advertisement on page 101)

Heinrich Co., Carl, 677 Beacon St., Boston, Mass.
Astronomical instruments

Heise Bourdon Tube Co., Brook Rd., Newton, Conn.
Bourdon tube devices
(See advertisement on page 74)

Helicoid see American Chain & Cable Co.

Helipot Corp., 916 Meridan Ave., South Pasadena 8, Calif.
Rheostats, voltage dividing resistors
(See advertisement on page 104)

Heller Co., Gerald K., 1540 Ridgely St., Baltimore 30, Md.
Manual motor controls

Hellige, Inc., 3718 Northern Blvd., Long Island City, N. Y.
Scientific instruments, laboratory & bacteriological supplies

Henderson & Co., H. B., East Liverpool, Ohio
Pyrometric cones

Henry Valve Co., Inc., 3215 W. North Ave., Melrose Park, Ill.
Control valves

Henschel & Co., Inc., John, 105 E. 29th St. New York 16, N. Y.
Drawing instruments

Henson Co., Fred C., 3311 E. Colorado St., Pasadena, Calif.
Electroscopes, optical instruments and components
(See advertisement on page 166)

Henszey Co., Watertown, Wis.
Feed water meters, flow indicators continuous blowdown, heat exchangers and boiler feed regulators. Also meters and flow indicators for corrosive chemicals.

Herbach & Rademan, Inc., 522 Market St., Philadelphia 6, Pa.
Electronic instruments

Herman Stone Co., 324 Harries Bldg., Dayton 2, Ohio
Precision granite surface plates

Herron Optical Co., 705 W. Jefferson Blvd. Los Angeles 7, Calif.
Lenses, mirrors and optical parts

Hetherington & Berner, 701 Kentucky Ave., Indianapolis 7, Ind.
Fluidometers

Hetherington & Son, Inc., Robert, 1200 Elmwood Ave., Sharon Hill, Pa.
Switches

Heusser Instrument Mfg. Co., 1388 S. State St., Salt Lake City 4, Utah
Analytical balances

Hevi Duty Electric Co., Milwaukee 1, Wis.
Electric furnaces

Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, California
Electronic equipment

Hexacon Electric Co., 179 W. Clay Ave., Roselle Park N. J.
Electric soldering irons

Heyman Mfg. Co., 530 Michigan Ave., Kenilworth N. J.
Inspection instruments

H & H Thermostats, Inc., 682 Broadway, New York 12, N. Y.
Altimeters, recording thermometers, recorder ink for extreme temperatures

Hickok Electric Instrument Co., 10519 Dupont Ave., Cleveland 8, Ohio
Electric indicating instruments

Hiergesell & Sons, Wm., 295 Pearl St., New York 7, N. Y.
Thermometers & hydrometers

High Voltage Engineering Corp., 7 University Road Cambridge, Mass.
High voltage devices

Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill.
Diaphragm valves, metering and proportioning pumps

Hillyer Instrument Co., Inc., 54-60 Lafayette St., New York 13, N. Y.
Computers and inspection devices

Hoke, Inc., 148 S. Dean St., Englewood, N. J.
Regulators

Holtzer-Cabot Electric Div., National Pneumatic Co., Inc., 125 Amory St., Boston, Mass.
Fractional Horsepower Motors

Hopp Press, Inc., 460 W. 34 St., New York 1, N. Y
Nameplates, dial faces, scales, instruction plates

Houston Technical Laboratories, 2424 Branard St., Houston 6, Texas
Gravity meters for geophysical prospecting

Howe & French Inc., 99 Broad St., Boston 10, Mass.
Laboratory supplies

Howe Scale Co., Rutland, Vt.
Scales

Howland Optical Co., 29 Cottage Place, Nutley, N. J.
Optical flats lenses, magnifiers

Hufco Industries, 2815 W. Olive St., Burbank, Calif.
Relays

Huggins Labs., 700 Hamilton Ave., Menlo Park, Calif.
Laboratory instruments, industrial photoelectric instruments, fused quartz apparatus, colorimeters

Hull Mfg. Co., P. O. Box 246, Warren Ohio
Compasses

Humboldt Mfg. Co., 2014 N. Whipple St., Chicago 47, Ill.
Cement & concrete testers

Hunter Spring Co., Lansdale, Pa.
Special springs

Huppert Co., K. H., 6830 Cottage Grove Ave., Chicago, Ill.
Laboratory furnaces

Hycon Mfg. Co., 2961 E. Colorado St., Pasadena 8, Calif.
(See advertisement on page 102)

Hycor Co., Inc., 11423 Vanowen St., North Hollywood, Calif.
Electric and electronic components

Hydraulic Div., New York Air Brake Co. 420 Lexington Ave., New York, N. Y.
Hydraulic control systems

Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
Electronic tubes

I

Ice Optical Co., Herchel C., 1003 North 11 St., Reading, Pa.
Lenses, mirrors, optical flats, telescopes

Ideal Industries, Inc., 1420 Park Ave., Sycamore, Ill.
Insulation testers & revolution counters

Ideal Laboratory Tool & Supply Co., 3913 Evans Ave., Cheyenne, Wyo.
Aircraft instrument test apparatus, sensitive needle valves
(See advertisement on page 34)

Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10, Ill.
Indicating pyrometers, resistance thermometers pyrometer controllers air velocity meters, metal detectors
(See advertisement on page 13)

Impact Register Co., 510 N. Neil St., Champaign, Ill.
Instruments for determining and recording impacts received by railroad cars and riding qualities of railroad cars, automobiles

Impact-O-Graph Corp., 1900 Euclid Ave., Cleveland, Ohio
Impact recorders

Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.
Fittings, tubing cutters and benders

Indiana Steel Products Co., Valparaiso, Ind.
Instrument magnets

Inductograph Products Inc., 236 W. 55th St., New York, N. Y.
Regulated power supplies

Industrial Condenser Corp., 3243 N. California Ave., Chicago 18, Ill.
Oil paper & electrolytic capacitors

Industrial Control Co., Straight Path and Arlington Ave., Wyandanch, L. I., N. Y.
Electrical instruments, servo amplifiers

Industrial Electronics, Inc., 8060 Wheeler St., Detroit 10, Mich.
Cathode-ray oscillograph
(See advertisements on pages 16, 17)

Industrial Engineering Corp., Rea Bldg., Terre Haute, Ind.
Relays

Industrial Filter & Pump Mfg. Co., 5900 Ogden Ave., Chicago 50, Ill.
Salt spray testers

Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.
Electrical measuring & test equipment
(See advertisement on page 40)

Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio
Nuclear instruments, inspection devices

Industrial Pyrometer & Supply Co., Alton, Ill.
Thermocouples
(See advertisement on page 61)

Industrial Scientific, Inc., 317 Nagle St., Houston 1, Texas
Laboratory supply house

Industrial-Scientific Supply Co., 1014 Taylor St., Fort Worth 2, Texas
Laboratory supplies

Industrial Timer Corp. 117 Edison Place, Newark 5, N. J.
Industrial timers, motor driven, with automatic reset. Controllers, signals, testing equipment for electrical parts (operation or life test)

Industrol Corp., Roselle Park, N. J.
Air dryers and gas sample dryers
(See advertisement on page 43)

Inferno Co., Box 1138, Shreveport 90, La.
Combustion instruments

Ingersoll-Rand Company, Phillipsburg, Pa.
Instrument air compressors
(See advertisement on page 22)

Instron Engineering Corp., 2, Hancock St., Quincy 71, Mass.
Testing machines

Instrumaster Industries, Inc., 110 Sherman Ave., New York 34, N. Y.
Drawing instruments

Instrument Development Labs., Inc., 163 Highland Ave., Needham Heights 94, Mass.
Photoelectric color analyzers

Instrument Electronics Corp., 104 W. Jefferson St., Falls Church, Va.
Electronic instruments

Instrument Laboratories, 315 W. Walton Place, Chicago 10, Ill.
Electrical testing sets
(See advertisement on page 44)

Instrument Laboratory Inc. P. O. Box 4098, Interbay Station, Seattle 99, Washington
Counting & indicating instruments

Instrument Repair & Mfg. Co., 1258-48th Ave., Oakland 1, Calif.
Diaphragm valves and controllers

Instrument Resistors Co., 1036 Commerce Ave., Union, N. J.
Instrument resistors

Instruments Corp., 4 N. Central Ave., Baltimore 2 Md.
Meteorological instruments

International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.
Scales & time instruments

International Equipment Co., 1284 Soldiers Field Road, Brighton, Boston 35, Mass.
Analytical centrifuges

International Glass Corp., 119 S. Beverly Drive, Beverly Hills, Calif.
Lenses, prisms and optical parts

International Instruments, Inc., 486 Derby Ave., West Haven, Conn.
Electrical instruments

International Microscope & Art Co., 1670 West Ogden Ave., Chicago 12, Ill.
Microscopes

International Rectifier Corp., 6809 S. Victoria Ave., Los Angeles 43, Calif.
Photoelectric cells and dry disc rectifiers
(See advertisement on page 114)

International Register Co., 2620 W. Washington Blvd., Chicago 12, Ill.
Coin meters—timers for electric ranges & gas ovens

International Resistance Co., 401 N. Broad St., Philadelphia 8 Pa.
Metallized & wirewound fixed & variable resistors including high voltage & high frequency types

Islip Radio Mfg. Corp., Foot of Beech St., Islip, N. Y.
Amplifiers

Ithaca Scientific Instrument Co., Ithaca, N. Y.
Drawing instruments

J

Jackson Electrical Instrument Co., 18 S. Patterson Blvd., Dayton 1, Ohio
Radio testing equipment

Jacobs Instrument Co., 4718 Bethesda Ave., Bethesda 14, Md.
Ballistic instruments

Jaeger Watch Co., Inc., 304 East 45th St., New York 17, N. Y.
Automobile clocks, timepieces for aviation and marine, chronomatic tachometers & true airspeed indicators

Jansson Gage Co., 19206 Glendale Ave. Detroit 23, Mich.
Gages; gage blocks—special, built up; flush pin and thread gages, carboloy or steel

Jardur Import Co., 874 Broadway, New York 3, N. Y.
Chronographs & stop-watches

Jarrell-Ash Co., 165 Newbury St., Boston 16, Mass.
Representatives for Adam Hilger, Ltd., manufacturers of optical instruments

J B L Instrument Co., Sycamore & Mill Rd. Clifton Heights, Pa.
Rotary instrument switches, transformer tapping, railway signal gear, decade resistance boxes

J-B-T- Instruments, Inc., 443 Chapel St., New Haven 8, Conn.
Electrical measuring & controlling instruments: pyrometers, thermocouples selector switches, potentiometers, resistance thermometers, laboratory instruments
(See advertisement on page 156)

Jeffrey Mfg. Co., 795 N. 4 St., Columbus 16, Ohio
Weighing, feeding, batching & proportioning equipment
(See advertisement on page 69)

Jenkins Bros. 80 White St., New York 13, N. Y.
Regulating valves

Jerguson Gage & Valve Co., 87 Fellsway, Somerville 45, Mass.
Precision gages & valves
(See advertisement on page 72)

Jo-Bell Products, Inc., 4840 South St. Louis Ave., Chicago 32, Ill.
Liquid level alarms, magnetic proximity switches
(See advertisement on page 40)

Johnson Co., E. F., Gothard Div., Waseca, Minn
Connectors, plugs, dial lights, etc.

Johnson Gage Co. 534 Cottage Grove Rd., Bloomfield, Conn.
Comparators & gages

Johnson Scientific Instrument Co., 2915 Maples Ave., Berwyn, Ill.
Biological instruments, instrument-repair tools

Johnson Service Co., 507 E. Michigan St., Milwaukee 2, Wisc.
Automatic temperature & humidity control for heating, cooling, ventilating, air conditioning & industrial processes

Johnson-Williams, Ltd., Box 8, Palo Alto, Calif.
Combustible gas indicators & alarm systems, portable & continuous, including accessories
(See advertisement on page 82)

Johnston & Jennings Company, 877 Addison Rd., Cleveland 14, Ohio
Depth gages, valves

Jones, Howard B. Div., Cinch Mfg. Co., 1026 S. Homan Ave., Chicago 24, Ill.
Connectors

Jones Electronics Co., M C., 96 N. Main St., Bristol, Conn.
Standing wave meter

Jones & Lamson Machine Co., Clinton & Whitmore Sts., Springfield, Vt.
Optical comparators

Jones-Motrola Corp. 432 Fairfield Ave., Stamford, Conn.
Tachometers, speed indicators & speedometers

Jones Optical Works, A. D., 2400 Massachusetts Ave., Cambridge, Mass
Lenses, light filters and optical parts

K

Kahl Scientific Instrument Co., Inc., El Cajon, Calif.
Thermometer, hydrometer, psychrometers, hygrometers

Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif.
Audio frequency equipment, bridges, capacitance meters

Kansas City Laboratory Supply Co., 1434 Wyandotte St., Kansas City 6 Mo.
Laboratory supplies

Karn Chemical Equipment Co., 518 Dickson Ave., Pittsburgh 2, Penna.
(See advertisement on page 138)

Karp Metal Products Co., Inc., 211-277 63 St., Brooklyn, N. Y.
Instrument panels

W. A. Kates Co., 430 Waukegan Rd., Deerfield, Ill.
Automatic flow and pressure controllers

Kauffman-Lattimer Co., 230 N. Front St., Columbus 16, Ohio
Laboratory supplies

Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.
Electronic instruments

Kaydel Moisture Gauges, 126 Liberty St., New York 6, N. Y.
Moisture meters
(See advertisement on page 94)

Keckley Mfg. Co., 400 W. Madison St., Chicago 6 Ill
Steam and liquid control equipment

Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio
Amplifiers

Kelley-Koett Mfg. Co., Instrument Div., 930 York St., Cincinnati 14, Ohio
Radioactive detectors

Kelley-Koett Mfg. Co., Inc., Covington, Ky.
X-Ray apparatus

Kellogg Switchboard & Supply Co., 6650 S. Cicero, Chicago 38 Ill.
Relays

Kent Cliff Laboratories, P. O. Box 696, Peekskill, N. Y.
Hardness testers

Kenyon Instrument Co., Inc., 1345 New York Ave. Huntington, L. I., N. Y
Airport & marine instruments

Kepco Laboratories, 149-14 41st Ave., Flushing, L. I., N. Y.
Radio test panels
(See advertisement on page 1)

Kessler Co., Walter H., 180 Lafayette St., New York, N. Y.
Thermometers and hydrometers

Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill.
Cored solders

Keuffel & Esser Co., Adams & Third Sts., Hoboken, N. J.
Surveying instruments

Kewaunee Mfg. Co., End of So. Center St., Adrian Mich.
Laboratory furniture

Keystone Carbon Co., Inc., Saint Marys, Pa.
Carbon resistors

Kieley & Mueller Inc., 2013-2033—43 St., North Bergen, N. J.
Pressure regulating & flow control devices
(See advertisement on page 57)

Kimble Glass Co., Vineland, N. J.
Glass apparatus, glass tubing, thermometers, hydrometers

King, Andrew, 519 Broad Acres Road, Narberth Pa.
Portable Brinell hardness tester

King Engineering Corporation, Box 70, Ann Arbor, Mich.
Liquid level indicators, distant reading
(See advertisements on pages 73, 89)

Kirk & Blum Manufacturing Co., 3120 Forrer St., Cincinnati 9, Ohio
Instrument panels and sheet metal assemblies

Klett Mfg. Co. 179 E. 87th St., New York 28, N. Y.
Colorimeters

Klipfel Valves Inc. Div. Hamilton Thomas Corp., 1001 Laurel Ave., Hamilton, Ohio
Regulating valves

Knights Company, James, Sandwich, Ill.
Crystals

Knopf Instrument Co., 250 Culver Ave., Jersey City, N. J.
Counters and vehicle instruments

Koch & Co., F. A. 72 Spring St. New York 12, N. Y.
Laboratory supplies

Koehler Instrument Co., 168-56 Douglas Ave., Jamaica 3, N. Y.

Kollmorgan Optical Co., 2 Franklin Ave., Brooklyn 11, N. Y.
Astronomical & optical instruments

Kollsman Instrument Div., Square D Co., 80-08—45th Ave., Elmhurst Long Island, N. Y.
Precision instruments for aircraft

Kontes Glass Co., Spruce St., Vineland, N. J.
Glass apparatus, instruments and parts

Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.
Computers, nuclear instruments

Krouse Testing Machine Co., 573 E. 11th Ave., Columbus 3, Ohio
Fatigue testing machines

L

L. A. B. Corp., P. O. Box 162, Summit, N. J.
Special instruments

Laboratory Construction Co., 1113-15 Holmes St. Kansas City 6, Mo.
Laboratory furniture & apparatus

Laboratory Equipment Corp., Box 352, St. Joseph, Mich.
Carbon & sulphur determinators

Laboratory for Electronics, Inc., 11 Lean St., Boston 15, Mass.
Computers, electrical and electronic instruments

Laboratory Furniture Co., Inc., Old Country Road, Mineola, L. I., N. Y.
Laboratory furniture

Laboratory Materials Co., 7319 Vincennes Ave. Chicago 21, Ill.
Laboratory supplies

Laboratory Specialties, Inc., 144 S. Wabash St., Wabash, Ind.
Mirrors—front surfaces & aluminized: Monochromatic light sources, Black light apparatus, Diffraction gratings, Spectroscopes, Fluorescent & phosphorescent materials

La Marche Mfg. Co., 6525 Olmstead Ave., Chicago 3, Ill.
Constant voltage regulators, rectifiers

Lambda Electronics Corp., Corona, N. Y.
Power supplies
(See advertisement on page 106)

Lammert & Mann Co. 260 N. Woods St., Chicago 12, Ill.
Flow regulators & valves

LaMotte Chemical Products Co., Towson, Md.
Hydrogen ion apparatus

Lampkin Laboratories, Inc., Bradenton, Fla.
Radio-frequency meters

Lancaster Lens Co., 220 N. Main St., Lancaster, Ohio
Optical components

Landis & Gyr, Inc., 45 West 45th St., New York 19, N. Y.
Electric integrating meters; indicating & graphic demand meters for KW, KVA, reactive; prepayment meters; totalizing & remote; time switches; motor wound escapement or synchronous motor types with astronomic dials; miniature ball bearings

Lansing Engineering Co., Electronics Div. 735 E. Kalamazoo St., Lansing, Mich.
Counters & timers

La Pine & Co., Arthur S., 121 W. Hubbard St., Chicago 10, Ill.
Laboratory supplies

Lapp Insulator Co., Inc., Le Roy, N. Y.
Automatic feeders and regulators, pumps, laboratory ware

Larrimore Sales Co., P. O. Box 1234, St. Louis 1, Mo
Magnifiers

LAWTER...
Leader in Luminescence

PHOSPHORESCENT—FLUORESCENT PAINT SPECIALISTS

•

PIONEERS IN INSTRUMENT BLACK LIGHTING

•

Write for Technical Release 108 and Swatches

LAWTER CHEMICALS INC.
3563 Touhy Avenue
Chicago 45, Illinois

Lavoie Laboratories, Matawan Freehold Rd., Morganville, N. J.
Ultra high frequency precision frequency meter

Lawrence & Hill, Inc., 142 Main Ave., Watertown, N. Y.
Gages & gaging fixtures

Lawter Chemicals Inc., 3563 Touhy Ave., Chicago 45, Ill.
Luminous and fluorescent chemicals and coatings
(See advertisement on page 169)

Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.
Relays

Lear, Inc., 110 Ionia Ave., N. W. Grand Rapids 2, Mich.
Electronic & mechanical aircraft accessories; aircraft radio equipment, radio compasses, etc.

Lectrohm, Inc., 5939 S. Archer Ave., Chicago 38, Ill.
Resistors

Ledeen Mfg. Co., 1600 S. San Pedro St., Los Angeles 15, Calif.
Automatic control valves

Leeds & Northrup Co., 4970 Stenton Ave. Philadelphia 44, Pa.
Electrical measuring instruments for both laboratory & plant. For laboratory: bridges, galvanometers, potentiometers, photometric equipment, test sets & standards. For plant: indicators, recorders & controllers for chemical concentration, CO_2, current, electrolytic conductivity frequency, gas analysis, humidity, Kw, Rkva, light, electrical load, pH, pressure, pyrometry, radiation, smoke density, speed temperature, voltage, Speedomax Recorders, Centrimax Flowmeters & Metermax Combustion control Systems

Leitz Inc., E., 304 Hudson St., New York 13, N. Y.
Optical instruments

Leland Inc., G. H., 123 Webster Ave., Dayton 2, Ohio
Circuit selector switches, stepping relays, solenoids

Lenkurt Electric Co., 1118 County Road, San Carlos, Calif.
Ultrasonic-frequency transformers, metallic dust cored: inductors, electric wave filters

Lenox Instrument Co., 2010 Chancellor St., Philadelphia 3 Pa.
Optical and technical instruments

Leslie Co., Grant Ave. and Val Brook Ave., Lyndhurst, N. J.
Pressure reducing valves, pump governors, temperature regulators
(See advertisement on page 147)

Leupold & Stevens Instruments, 4445 N. E. Glisan St. Portland 13, Ore.
Recorders & indicators, for irrigation, power, waterworks, sewerage. Equipment for hydraulic laboatories. Snow-rain recorders, hydrographic accessories, transits, levels

Levin & Son, Louis, 782 E. Pico Blvd., Los Angeles, Calif.
Instrument lathes

Lewis & Co., J. B., 3324 Main St. Hartford 5, Conn.
Motor controls, adjustable speed-electronic exciters

Lewis & Kaufman, Inc., Los Gatos, Calif.
Electron tubes

Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Portable pyrometers, potentiometers, resistance thermometers & other electrical tmperature measuring devices
(See advertisement on outside back cover)

Lewyt Corp., 60 Broadway, Brooklyn 11, N. Y.
Instrument housings

Librascope Inc., 1607 Flower St., Glendale 1, Calif.
Mechanical and electrical computers and analyzers, magnetic instruments
(See advertisement on page 58)

Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill.
Laboratory furnaces and controls

Linde Air Products Co., 30 E. 42nd St. New York 17, N. Y.
Gas gages, gas flowmeters, oxygen regulators

Lindly & Co., 8 Herrick Rd., Mineola, L. I., N. Y.
Optical components, illuminators

Link Aviation Devices, Inc., Binghamton, N. Y.
Aircraft navigational instruments

Link Engineering & Mfg. Co., 13845 Elmira St., Detroit 27, Mich.
Spring testers

Lion Mfg., Inc., 106 N. Grant Ave., Columbus, O.
Balancing machines, vibration pickups

Liquidometer Corp., 36-16 Skillman Ave., Long Island City 1, N. Y.
Liquid level gages

Liquid Scale Gauge Co., 100 N. First St., Minneapolis 1, Minn.
Liquid level indicating gages

Liquidepth Indicators, Inc., 43-22 10 St., Long Island City 1, N. Y.
Level gages

Liston-Folb Instrument Co., Inc., 20 Beckley Ave., Stamford, Conn.
Gas analyzers, amplifiers

Little, Inc., Arthur D., Memorial Drive, Cambridge 42, Mass.
Chemical feeds and special equipment

Logan Engineering Co., 4901 W. Lawrence Ave., Chicago 30, Ill.
Compressed air and gas separators

Littelfuse Inc., 4757 N. Ravenswood Ave., Chicago 40, Ill.
Low amperage precision fuses & fuse mountings
(See advertiscment on page 86)

Lonergan Co., J. E., 213 Race St., Philadelphia, Pa.
Pressure gages

Lord Mfg. Co., 1635 W. 12 St., Erie, Pa.
Bonded rubber vibration isolation mountings & flexible couplings for practical horsepower motors

Lovins Engineering Co., 8203 Cedar St., Silver Springs, Md.
Scientific instruments and apparatus

L & R Manufacturing Co., 577 Elm St., Arlington N. J.
Instrument cleaning machines & cleaning & rinsing solutions, Crystal cement

Loudon Instruments, Inc., 5644 S. Lake Park Ave., Chicago 37, Ill.
Nuclear instruments, bridges and potentiometers, temperature instruments

Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Precision tools & measuring tapes

Lumenite Electronic Co., 407 S. Dearborn St. Chicago 5, Ill.
Photoelectric controls

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SCALES, RETICLES, CIRCUITRY, VIEWING SCREENS

- **dimensional accuracy**
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Wm. I. Mann Co.
PRECISION OPTICS
1015 MISSION ST.
SOUTH PASADENA
CALIF.

Lux Clock Mfg. Co., 95 Johnson St., Waterbury 91, Conn.
Automatic timers & clock mechanisms

Lyman Electronic Corp., 12 Cass St., Springfield Mass.
Radio test instruments

M

Macalaster Bicknell Co., 234 Broadway, Cambridge 39, Mass.
Laboratory glass apparatus

Macbeth Corp., P. O. Box 950, Newburgh, N. Y.
Hydrogen ion meters

Macbeth Daylighting Corp., 227 West 17 St., New York 11, N. Y.
Daylight lamps for titration & color matching

Machlett Laboratories, Inc., Springdale Conn.
Vacuum tubes

Machlett & Son, E., 220 East 23rd St., New York 10, N. Y.
Laboratory apparatus & supplies

MacDonald Co., Inc., W. S. 33 University Road, Cambridge 38, Mass.
Microammeters, bolometers and magnetometers
(See advertisement on page 63)

MacLeod & Hanopol, Chelsea & Joiner St., Charlestown 29, Mass.
Radio testing instruments

Madison Electrical Products, Div., John G. Ruckelshaus Co., Madison, N. J.
Chokes, resistances

Magnaflux Corp., 5900 Northwest Highway Chicago 31, Ill.
Magnetic inspection equipment

Magnatrol Valve Corp., 67 Fifth Ave., Hawthorne, N. J.
Control valves

Magnavox Co., Inc., 2131 Bueter Rd., Fort Wayne 4, Indiana
Electrolytic capacitors

Magnecord Inc., 360 N. Michigan Ave., Chicago 1, Ill.
Magnetic tape recorders
(See advertisement on page 113)

Magnetic Amplifiers Inc., 11-54 44 Drive, Long Island City 1, N. Y.
Telemetering components, magnetic tape recorders

Magnetic Analysis Corp., 42-44 12th St., Long Island City 1, N. Y.
Magnetic inspectors for uniform cross-sectional steel

Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.
Flow and level controls
(See advertisement on page 62)

Mahady Co., E. F. 857 Boylston St., Boston 16, Mass.
Laboratory supply house

Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Capacitors, switches

Mann Co., Wm. I., 1015 Mission St., South Pasadena, Calif.
Astronomical instruments, optical flats and components, laboratory apparatus and test equipment
(See advertisement on page 169)

Manning Maxwell & Moore, Inc., 11 Elias St., Bridgeport 2, Conn.
Thermometers, glass, dial & recording; controllographs; indicating & recording controllers; diaphragm motor valves; tachometers, barometers; & hygrometers

Mansfield & Green, 1051 Power Ave., Cleveland 14, Ohio
Gages and dead weight testers

Marco Industries Inc., Depew, N. Y.
Instrument and servomechanism motors

Marconi Instruments Ltd., 23 Beaver St., New York 4, N. Y.
Electrical and electronic instruments, frequency standards, amplifiers

Marble-Card Electric Co., Gladstone Mich.
Fractional H P motors

Marine Compass Co., Pembroke, Mass.
Marine instruments

Marion Electrical Instrument Co., 400 Canal St., Manchester, N. H.
Electrical indicating instruments

Maris Co., John M., 2100 Arch St., Philadelphia 6, Pa.
Laboratory apparatus

Marsh Corp., Jas. P., 3501 Howard St., Skokie, Ill.
Indicating gages, recording gages, dial thermometers, recording thermometers, refrigeration service instruments, temperature controlling systems, valves for heating systems
(See advertisements on pages 79, 137)

Marshall Co., C. & E., 1445 West Jackson Blvd., Chicago 80 Ill.
Manufacturers & distributors of jewelers, watchmakers & engravers supplies

Marshall Co., L. H., 270 W. Lane Ave., Columbus Ohio
Laboratory furnaces and foundry thermocouples

Marshalltown Mfg. Co., Marshalltown, Iowa
Pressure gages & indicating thermometers
(See advertisement on page 79)

Martin-Hubbard Corp., 50 Follen St., Cambridge, Mass.
Designers of electrical, mechanical and optical instruments

Mason-Neilan Regulator Co., 1190 Adams St., Boston 24, Mass.
Industrial control equipment for pressure temperature, flow, liquid level, combustion & ratio, diaphragm control valves; pressure & vacuum regulators; level controllers; pump speed governors; pump pressure regulators; pipe strainers

Massa Laboratories Inc., 5 Fottler Rd., Hingham, Mass.
Acoustic instruments, sound pressure measurement standards

Matthews Instrument Co., 1350 Burlington Ave., Bristol, Conn.
Odometers

Maurer, Inc., J. A., 37-01 31 St., Long Island City, 1 N. Y.
Motion picture cameras

Maveg Machine Sales Association, Chamber of Commerce Bldg., Long Island City, N. Y.
Dilatometers, dual comparators

Maxson Corp., W. L., 460 West 34 St., New York 1, N. Y.
Aircraft instruments, computing machines, integrators gyro stabilizers, aircraft and naval current controls
(See advertisement on page 105)

Maymer Corp., 10884 Berea Rd., Cleveland 2, Ohio
Scales, dials & templates

M B Mfg. Co., Inc., 1060 State St., New Haven, Conn.
Electrical instruments

McAlear Manufacturing Co., 1901 S. Western Ave., Chicago 8, Ill.
Manual & automatic controls for air, oil, gas, steam, chemicals pure food, acid & alkali

McDonnell Odometers Co., 3501 So. Kedzie Ave., Chicago 32, Ill.
Counters

McFarlin Co., 29 West Marion Ave., Youngstown 2, Ohio
Leak detectors

McKesson & Robbins, Inc., 1706 First Ave., Birmingham 3, Ala.
Laboratory supplies

McNeill Engineering Co., S. J., 4057 West Van Buren St., Chicago 24, Ill.
Smoke alarms

Mead Specialties Co., 4114 North Knox Ave., Chicago 41, Ill.
Control valves

Measurements Corp., Boonton, N. J.
Radio frequency Testing & Measuring Devices
(See advertisements on inside back cover and pages 69, 82)

Mechanical Industries Production Co., 209 Ash St., Akron 3 Ohio
Thermostats

Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Calif.
Pressure operated switches

Menlo Research Laboratory, P. O. Box 522, Menlo Park, Calif.
Micrometers, instrument shop tools, electron tubes, counters

Mepco Inc., 37 Abbett Ave., Morristown, N. J.
Standard and special resistors

Mercoid Corp., 4201 Belmont St., Chicago 41, Ill.
Automatic controls for heating, refrigeration air conditioning & various industrial applications
(See advertisements on page 30)

Mercon Regulator Co., 2357 N. 29th St., Milwaukee 10, Wis.
Power plant specialties in regulation of pressure, level, rate of flow, proportioning & temperature

Mercury Glass Co., Pleasantville, N. J.
Glass tubing

Meriam Instrument Co., 10920 Madison Ave. Cleveland 2, Ohio
Manometers, draft gages, indicating flow meters for steam, oil, gas, air, water, tank liquid level gages
(See advertisements on pages 77, 89, 90, 92)

Merit Transformer Corp., 4427 No. Clark, Chicago 7, Ill.
Transformers, coils & reactors, electrical windings

Merkle Korff Gear Co., 214 North Morgan St., Chicago 7, Ill.
Motorized speed reducers: induction, synchronous, reversing, d-c universal motors
(See advertisement on page 94)

Merrick Scale Mfg. Co., Autumn St., Passaic, N. J.
Automatic continuous weighing machines

Merritt Engg. & Sales Co., Inc., 120 So. Niagara St., Lockport, N. Y.
Consistency controls

Merz Engineering Co., 200 S. Harding St., Indianapolis 7 Ind.
Gages & gaging fixtures

Metal Goods Corp., 5239 Brown Ave., St. Louis 5, Mo.
Tube fittings

Metlab Equipment Corp., 270 Duffy Ave., Hicksville, L. I., N. Y.
Laboratory furniture

Meters, Incorporated, P. O. Box 5904, Indianapolis 20, Ind.
Electrical indicating instruments

Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.
High frequency amplifiers, electric instruments, oscillators, radio remote control systems, comparator gages electric tachometers, timers, chronographs

Metrotype Corp., 525 W. 76 St., Chicago 20, Ill.
Frequency regulators, recording ammeters, remote reading equipment, counters

Metzger & Son., F. F., 2600 N. 6 St., Philadelphia 33, Pa.
Extensometers and gages

Meyer Scientific Supply Co., Inc., 221 Atlantic Ave. Brooklyn 2, N. Y.
Laboratory apparatus

Meyer Governor Co., 284 Baker Bldg., Minneapolis 2, Minn.
Long-distance recording, indicating, and contact-making instruments; gage pulsation protectors

Mico Instrument Co., 80 Trowbridge St., Cambridge, Mass.
Precision devices in industrial & scientific fields

Microchemical Service, 44-27 Dougleston Pkway, Douglaston, N. Y.
Microchemical laboratory apparatus

Micro Master Co., 2733 N. Pulaski Rd., Chicago 39 Ill.
Dial indicators & taper gages

Micro Metallic Corp., 30 Sea Cliff Ave., Glen Cove, N. Y.
Pressure snubbers

Micro Metric Instrument Co., 2891 E. 79 St., Cleveland 4, Ohio
Chemical and biological instruments

Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Illinois
Snap action switches

Midwestern Geophysical Lab., 2803 W. 40 St., Tulsa, Okla.
Geophysical instruments, amplifiers, galvanometers

Mid-West Dynamometer & Engg. Co. 3100 River Road, River Grove, Ill.
Dynamometers

Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Radio test instruments

Miller, M. C., 1142 Emerson Ave., W. Englewood, N. J.
Electrical instruments

Miller & Weber, Inc., 71-14 Myrtle Ave., Glendale 27, L. I., N. Y.
Liquid-in-glass thermometers

Millers Falls Co., Greenfield Mass.
Machine shop gages

Millivac Instruments, P. O. Box 3027, New Haven, Conn.
Special electronic instruments
(See advertisement on page 150)

Milo Radio & Electronics Corp., 200 Greenwich St., New York 7, N. Y.
Electronic laboratory apparatus
(See advertisement on page 38)

Milton Roy Company, 1309 E. Mermaid Ave., Philadelphia 18, Pa.
Automatic feeders & flow controllers

Milwaukee Gas Specialty Co., 730 N. Jackson St., Milwaukee 1, Wis.
Valves, fittings & safety shut-offs for gas fired equipment

Milwaukee Precision Instrument Co., 5024 N. 37 St., Milwaukee 9, Wis.
Governors, tachometers

Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh 8, Pa.
Instruments for the detection, analysis & recording of toxic and combustible gases; instruments for sampling, counting & measuring dust particles
(See advertisement on page 8)

Mine & Smelter Supply Co., 1422-17th St., Denver, Colo.
Industrial equipment & supplies

Minneapolis Elec. & Construction Co. 80 South 12th St., Minneapolis 4, Minn.
Wire length measuring machines

Minneapolis-Honeywell Reg. Co., Industrial Div., 4482 Wayne Ave., Philadelphia 44, Pa.
Thermocouple & optical pyrometers, resistance thermometers, pressure thermometers, pressure gages, flow meters, liquid level gages, hygrometers, CO_2 meters, control systems; electric air-operated & combined electric & air-operated; combustion safety controls, moisture content recorder & controller & furnace atmosphere recorder
(See advertisements on pages 56, 62, 78, 91, 92, 106, 108, 110, 114, 138, 143, 150)

Minneapolis-Honeywell Reg. Co., 2727 - 4 Ave., S. Minneapolis 8, Minn.
Heating, ventilating and air conditioning control equipment; thermostats; safety controls; motor and diaphragm operated valves; relays; furnace controllers

Minnesota Electronics Corp., 47 W. Water St., St Paul 1, Minn.
Electrical and electronic instruments

Mittelman Electronics Div., Century America Corp., 549 W. Washington Blvd., Chicago 6, Ill.
Electromagnetic flowmeters, proportional meters, micro balances
(See advertisement on page 71)

Model Engineering & Mfg Co., 2800 N. Milwaukee Ave., Chicago 18, Ill.
Resistors

Modern Electrical Laboratory, 6131 S. Wentworth Ave., Chicago 21, Ill.
Laboratory apparatus

Modern Kiln & Furnace Co., American & York Streets, Philadelphia 33, Pa.
Ovens, furnaces & controllers

Modev Co., 1825 Ravenwood Ave., Dayton, O.

Moeller Instrument Co., 132nd St. & 89th Ave., Richmond Hill, N. Y.
Thermometers hydrometers, etc.
(See advertisement on page 33)

Moisture Register Co., 1510 W. Chestnut St., Alhambra, Calif.
Moisture testing instruments & devices

Moline Furniture Works, Moline, Ill.
Laboratory furniture

Monarch Manufacturing Co., 2014 N. Major Ave., Chicago 39, Ill.
Radio set testers

Monarch Manufacturing Works, Inc., Salmon & Westmoreland Sts. Philadelphia, Pa.
Strainers, oil burner nozzles & regulating valves, viscosimeters

Monsell, J. R., Pitman, N. J.
Dynamometers

Montgomery Mfg. Co., 202-204 Main St., Owensville, Ind.
Program clocks

Moore Products Co., 901 E. Lycoming St., Philadelphia 24, Pa.
Industrial instruments

Moore & Co., Samuel, Mantura, Ohio
Polyethylene or vinal plastic coatings for instrument tubing
(See advertisement on page 144)

Morgan Instrument Co., 21420 Valerio St., Canoga Park, Calif.
Nuclear instruments, electron tubes, Geiger-Mueller tubes

Morganite, Inc., 3302-3320 48th Ave., Long Island City 1, N. Y.
Pyrometer tubes

Mosher Electronic Controls, 25 Boston Post Rd., Larchmont, N. Y.
Electronic bin level indicators & electronic load regulators for pulverizing machinery

Mossman, Inc., Donald P., 420 Lexington Ave., New York 17, N. Y.
Switches
Municipal Instrument Co., 3246 S. Cuyler Ave., Berwyn, Ill.
Magnetic dipping needles, pipe phone for checking leaks

Munsell Color Co., Inc., 10 E. Franklin St., Baltimore 2 Md.
Color comparators

Mu-Switch Corp., 38 Pequit St., Canton, Mass.
Snap action switches

Muter Co., 1255 S. Michigan Ave., Chicago 5, Ill.
Resistors

N

Nankervis Co., G. L., 19255 W. Davison St., Detroit 23, Mich.
Dynamometers, inspection and gaging equipment

Nash Engineering Co., 370 Wilson Road., South Norwalk, Conn.
Instrument air compressors
(See advertisement on page 18)

Nashville Surgical Supply Co. 401 Church St., Nashville 3, Tenn.

National Brass Co., 1600 Madison St., S. E., Grand Rapids 2 Mich.
Combustion & draft controllers

National Carbon Co., 30 E. 42 St., New York 17, N. Y.
Dry batteries

National Co., Inc., 61 Sherman St., Malden, Mass.
Capacitors and radio instruments

National Electric Controller Co., 5305 Ravenswood Ave. Chicago 40, Ill.
Rheostats

National Engineering Products Inc., Commerce & Savings Bldg., Washington 4, D. C.
Pressure gage equalizers

National Instrument Co., 246 Walnut St., Newtonville 60 Mass.
Electro-mechanical instruments & devices

National Instrument Co., 5005 Queensburg Ave., Baltimore 15, Md.
Automatic pippettes

National Instrument Laboratories, 1129 Vermont Ave., N.W., Washington 5, D. C.
Custom built instruments
(See advertisement on page 92)

National Research Corp., 70 Memorial Drive, Cambridge 42, Mass.
Optical products, high vacuum apparatus

National Scientific Co., 2204 W. North Ave., Chicago 47, Ill.
Laboratory supply house

National Time & Signal Corp., 21800 Wyoming Ave., Detroit 20, Mich.
Timers for welding & industrial process control

Naxon Utilities Corp., 3600 W. Touhy Ave., Chicago 45. Ill.
Instrument cleaning machines

Negus, T. S. & J. D., 69 Pearl St., New York 4, N. Y.
Nautical instruments

Nelson Section Liner Co., 229 W. Gardner St., DeKalb, Ill.
Drawing instruments

Nelson & Street, P. O. Box 4342, Takoma Park, Washington 12, D.C.
Chronographs, timers

Neomatic Inc., 879 Wellesley Ave., Los Angeles 49, Calif.
Master clocks, relays, switches

Neptune Meter Co., 50 W. 50th St., New York 20, N. Y.
Liquid meters

Neptune Pump Mfg. Co., 4912 N. 6 St., Philadelphia 20, Pa.
Metering and proportioning pumps, chemical feeders

Nester Company, Inc., L. G., Millville, N. J.
Oxygen regulators

Newark Wire Cloth Co., 336 Verona Ave., Newark, N. J.
Testing sieves

New Hampshire Ball Bearings Inc., 2 Main St., Peterborough, N. H.
Miniature ball bearings

New Hermes, Inc., 13-19 University Place, New York 3, N. Y.
Engraving machines
(See advertisement on page 69)

N. J. Laboratory Supply Co., 235 Plane St., Newark, N. J.
Laboratory supplies

New Jersey Meter Co., Plainfield, N. J.
Compressed air meters, separators for removing water & oil from compressed air lines, liquid flow indicators with low flow signaling circuit

N. Y. Laboratory Supply Co., Inc., 76 Varick S' New York 13, N. Y.
Laboratory supplies

New York Scientific Supply Co., 28 West 30 Street, New York, N. Y
Laboratory supplies

New York Transformer Co., Alpha, N. J.
Transformers

Newark Scale Works, 10-12 Hobson St., Newark 8 N. J.
Scales

Niagara Electrical Instrument Co., 559 Ellicott St., Buffalo, N. Y.
Electrical power analyzer

Nilsson Gage Co., Inc., P. O. Box 505, Poughkeepsie, N. Y.
Dimensional gages

Norcross Corporation, 247 Newtonville Ave., Newton 58, Mass.
Humidity controllers and recording viscosimeters
(See advertisement on page 64)

Nordstrom Valve Division of Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
Valves

Noris Instruments, Ltd., 105 E. 29th St., New York N. Y.
Drawing instruments

North American Instrument Co., 23 East 26 St., New York, N. Y.
Aircraft instruments

North American Manufacturing Co., 4455 E. 71st St., Cleveland 5, Ohio
Valves and valve operating devices

North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.
X-ray equipment

Northern Equipment Company, 1945 Grove Drive, Erie, Pa.
Boiler feed control

Northwest Instrument Co., 2313 Third Ave., Seattle 1, Wash.
Compasses

Norton Electrical Instrument Co., 83 Hilliard St., Manchester Conn.
Electrical instruments

Nosker Engineering Products, Yellow Springs, Ohio
Strain measuring equipment

Nuclear Development Laboratory, P. O. Box 7034, Kansas City, Mo.
Radium detectors

Nuclear Instrument & Chemical Corp., 233 West Erie St., Chicago 10, Ill.
Radioactivity detectors
(See advertisement on page 96)

Nuclear Research & Development, Inc., 1094 Sutter Ave., St. Louis 5, Mo.
Radiation detecting instruments and components, geophysical instruments

Nucleonic Corp. of America, 497 Union St., Brooklyn 31, N. Y.
Radiation detectors

Nurnberg Thermometer Co., Inc., 124 Livingston St., Brooklyn 2, N. Y.
Thermometers and hydrometers

Nye, Inc., Wm. F., New Bedford, Mass.
Instrument and watch oils

O

Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Radio and television parts

Offner Electronics, Inc., 5320 N. Kedzie Ave., Chicago, Ill.
Oscillographs

Ohaus Scale Corp. 10-12 Hobson St., Newark 8, N. J.
Analytical balances

Ohmite Mfg. Co., 4826 W. Flournoy St., Chicago, Ill.
Close control rheostats, fixed & adjustable power resistors, precision & non-inductive resistors, attenuators, tap switches and R. F. chokes.

Olsen Testing Machine Co. Tinius, Easton Road, Willow Grove, Pa.
Testing machines
Olympic Instrument Labs., P. O. Box 62, Cove, Wash.
Measuring machines

Omega Machine Co., 345 Harris St., Providence, R. I.
Chemical feeding equipment for dry or liquid materials, by volume or by weight

Optical Development Corp., 949 Broadway, New York 10, N. Y.
Magnifiers, microscope accessories

Optical Service & Development, 91 Canal St., New York 2, N. Y.

Optionic Research, Inc., 2400 Massachusetts Ave., Cambridge 40, Mass.
Biological instruments

Optron Laboratory, 2725 Salem Ave., Dayton 6, Ohio
Optical flats reflectors prisms
(See advertisement on page 100)

OPW Corp., 2735 Colerain Ave., Cincinnati 25, Ohio

Oregon Electronic Mfg. Co., 206 S.W. Washington St., Portland 4, Oregon
Regulated power supplies

Orton Ceramic Foundation, Edward, Jr., 1445 Summit St., Columbus 1, Ohio
Pyrometric cones

Oster Mfg. Co. John, Terminal Bldg., 1 Main St., Racine, Wis.
Fractional horsepower motors

P

Pacific Div., see Bendix Aviation Corp.

Pacific Optical Corp., 6145 West Century Blvd., Los Angeles 45, Calif.
Glass and plastic lenses

Pacific Scientific Co., Inc., 1430 Grande Vista Ave., Los Angeles 23, Calif.
Cable tension indicator

Pacific Universal Products Co., 168 N. Vista Ave., Pasadena 8, Calif.
Lenses and mirrors
(See advertisement on page 98)

Palmer Thermometers, Inc., 2511 Norwood Ave., Cincinnati, Norwood 12, Ohio
Industrial indicating "Red-Reading-mercury" thermometers, dial thermometers, recording thermometers
(See advertisement on page 21)

Palo-Myers Inc., 81 Reade St., New York 7, N. Y.
Laboratory supplies & boiler water testing equipment

Palos Optical Co., Box 6, Palos Hts., Ill.
Astronomical instruments, filters, optical flats, lenses, microscopes

Panellit, Inc., 7212 N. Clark St., Chicago 26, Ill.
Instrument panels, pressure indicators

Panoramic Radio Corp., 10 S. Second Ave., Mt. Vernon, N. Y.
Electronic instruments and inspection devices

Paragon Electric Co., Two Rivers, Wis.
Timers

Park Sales Co., 421 Canal St. New York 13, N. Y.
Micrometers and calipers

Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio
Pressure snubbers, valves, fittings for instrument tubing

Parks Co., Harry S., 101 North 33 St., Philadelphia, Pa.
Gages pressure instruments

Parr Instrument Co., 211-53 St., Moline, Ill.
Combustion bombs, calorimeters, hydrogenation apparatus, melting point apparatus

Partlow Corp., 2 Campion Rd., New Hartford, N. Y.
Temperature indicators & controllers, time delay relays

Passaic Analytical Laboratories, Inc., 228 Ayerigg Ave., Passaic, N. J.
Instrument cleaning machines
(See advertisement on page 86)

Pastor Stop Watch Co., 43 East Main St., Waterbury 22, Conn.
Stop watches

Patent Button Co., Patwin Instruments Div., Waterbury 20, Conn.
Chemical analyzers, polarographic analyzers, flame photometers, indicating potentiometers

Patterson Screen Div., E. I. duPont de Nemours & Co., Towanda, Pa.
X-ray intensifying and fluorscopic screens

Paul Valve Co., 683 Third Ave., New York 17 N. Y.

Paulstick & Sons, H. 2124 Fulton St., Brooklyn 33, N. Y
Thermometers

Pelouze Mfg. Co., 1228 Chicago Ave., Evanston, Ill.
Torque gages

Penberthy Instrument Co., 666 Adams St., Seattle 8, Wash.
Industrial and smoke periscopes

Penn Industrial Instrument Corp., 4110 Haverford Ave., Philadelphia 32, Pa.
Flow meters

Penn Optical & Inst. Co., 50 S. San Gabriel Blvd., Pasadena 8, Calif.
Optical parts

Perfex Corp., 500 W. Oklahoma Ave., Milwaukee 7, Wis.
Automatic temperature controls for oil burners, stokers, gas burners, refrigeration & air conditioning

Perkin-Elmer Corp., P. O. Box 730, Norwalk, Conn.
Optical instruments

Perkins & Son, Inc., B. F., Mullen Tester Div., P. O. Box 388, Holyoke, Mass.
Testers for leather, paper & textiles
(See advertisement on page 130)

Permo Incorporated, 6415 Ravenswood Ave. Chicago 26, Ill.
Instrument pivots & Contacts
(See advertisement on page 154)

Permutit Company, 330 West 42nd St., New York 18, N. Y.
Indicators & recorders for CO_2, specific gravity of natural manufactured or process gases, exhaust gas analysis, other uses where gas density guides operation

Petrometer Corp., 1 Star Square, Long Island City 1 N. Y.
Distant reading, liquid level tank gages

Pfaltz & Bauer, Inc., 350 5th Ave., New York 1, N. Y.
Laboratory control instruments

Phen-Trols, Inc., 15 Franklin Place, Rutherford, N. J.
Pyrometers, thermocouples, instrument and regulating transformers

Philadelphia Gear Works, Inc., G St. and Erie Ave., Philadelphia Pa.
Control valves

Philadelphia Thermometer Co., 6th and Sayuga Sts., Philadelphia 40, Pa.
Instruments for temperature indication, control & regulation
(See advertisement on page 137)

Philamon Labs., 5717 Third Ave., Brooklyn 20, N. Y.
Tuning forks
(See advertisement on page 145)

Philbrick Researches, Inc., George A., 230 Congress St., Boston 10, Mass.
Computors and analogs
(Ste advertisement on page 54)

Philips Manufacturing Co., 3475 W. Touhy Ave., Chicago, Ill.
Vapor degreasers & instrument cleaning machines

Phillips Control Corp., 84 W. Jefferson St., Joliet, Ill.
Relays and solenoids

Phillips Petroleum Co., Bartlesville, Okla.
Automatic analyzers, chemical composition recorders, laboratory apparatus

Phipps and Bird, Inc., 303 S. Sixth St., Richmond 5, Va.
Laboratory apparatus & chemicals

Phoenix Precision Instrument Co., 3803 N. 5th St. Philadelphia 40, Pa.
Laboratory equipment

Photocon Research Products, 1061 N. Allen Ave., Pasadena 7, Calif.
Precision mechanical instruments

Photographic Products Inc., 6916 Romaine St., Hollywood 38, Calif.
Recording and oscilloscope cameras

Photo Research Corp., 15024 Devonshire St., San Fernando, Calif.
Optical instruments and testers

Photron Instrument Co., 6516 Detroit Ave., Cleveland 2, Ohio
Photoelectric colorimeters
(See advertisement on page 101)

Photoswitch, Inc., 77 Broadway, Cambridge, Mass.
Industrial photoelectric controls including counting equipment, electronic timers & special electronic controls, smoke controls

Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Photo-electric elements, photometers electronic timing devices, photo-electric colorimeters, photo-electric exposure meters, densitometers

Physicists Research Co., 321 S. Main St., Ann Arbor, Mich.
Specialists in solution of unusual industrial research jobs, with special experience in machinery noise reduction, development of special instrumnts, & measurement of surface irregularities

Picker X-Ray Corp. 300 Fourth Ave., New York 10, N. Y.
X-ray equipment

Pickering Governor Co., Pickering St., Portland, Conn.
Governors

Pierce Watch Company, 22 West 48th St., New York 19, N. Y.
Stop watches

Pike & Co., E. W., Elizabeth B, N. J.
Illuminated magnifiers & microscopes

Pipe Machinery Co., 930 E. 70th St. Cleveland, Ohio
Inspection gages

Pitometer Log Corp., 237 Lafayette St., New York 12, N. Y.
Pilot tube flowmeters

Pittsburgh Instrument & Machine Co., 1026 Reedsdale St., Pittsburgh 12, Pa.
Brinell Machines, alternating impact machines, surveying instruments
(See advertisement on page 132)

Pittsburgh Lectrodryer Corp., P. O. Box 1766, Pittsburgh, Pa.
Instrument air dryers

Plastic Service Guild, 233 Condor St., East Boston 28, Mass.
Chemically resistant plastic coatings for metal

Plummer & Kershaw, 2757 Frankford Ave., Philadelphia 34, Pa.
Optical parts

Pneumercator Co., Inc., 305 E. 46 St., New York 17, N. Y.
Level indicators

Podbielniak, Inc., 341 East Ohio St., Chicago 11, Ill.
Scientific and industrial laboratory apparatus

Polarad Electronics Co., 100 Metropolitan Ave., Mrooklyn 11, N. Y.
Amplifiers, audiofrequency equipment, oscilators, remote control equipment

Polarized Light-Photoelastic Co., 96 Tompkins Circle, Staten Island 1, N. Y.
Photoelastic polariscopes

Polarizing Instrument Co., Mount Kisco, N. Y.
Photoelasticity apparatus

Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.
Electronic instruments, regulated power supplies

Poole Instruments Inc., 1816 Magnolia St., Dallas 1, Texas
Tube inside micrometer for big gun internal measurements and refinery still tubes

Porter, Inc., George K., Box 216, Hatboro, Pa.
Glass blowing, precision cylindrical and tapered tubing

Post Company, Frederick, P. O. Box 803, Chicago 90, Ill.
Instruments & equipment for architect & engineer

Post Machinery Co., 140 Elliotte St., Beverly, Mass.
High speed electronic counter

Potter & Brunfield Mfg. Co., Princeton, Ind.
Relays
(See advertisement on page 119)

Potter Aeronautical Co., 89 Academy St., Newark 2, N. J.
(See advertisement on page 70)

Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Capacitors

Potter Instrument Co., 115 Cutter Mill Road, Great Neck, L.I., N. Y.
Photoelectric counters and controls

Powers Regulator Co., 3400 Oakton St., Skokie, Ill.
Controls for air conditioning temperature & humidity; also water temperature controls, dial indicating & recording thermometers & steam traps
(See advertisements on pages 59, 136, 151)

Pratt & Whitney, Div. Niles-Bement Pond Co., West Hartford, Conn.
Machine shop instruments

Precise Co., 942 Kings Highway, Brooklyn 23, N. Y.
Optical and electrical instruments, fluorescent chemicals and tubes, ultraviolet light sources
(See advertisement on page 84)

Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst, L. I. N. Y.
Radio test instruments

Precision Gage & Tool Co., 320 East 3d St., Dayton 2, Ohio
Machine shop gages

Precision Products, Inc., 516 South Lansing St., Tulsa 5, Okla.
Time switches

Precision Radiation Instruments, Inc., 4113 W. Jefferson St., Los Angeles 16, Calif.
Alpha, beta and gamma counters

Precision Resistor Co., 334 Badger Ave., Newark 8, N. J.
Resistors

Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.
Standard & custom-built laboratory equipment

Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Scientific instruments

Precision Tube Company, 3824-26-28 Terrace St., Philadelphia, Pa.
Fine tubing & metal shielded wire
(See advertisement on page 146)

Preferred Utilities Mfg. Corp., 1860 Broadway, New York, N. Y.
Boiler plant instruments

Preis Engraving Machine Co., H. P., 651 State Highway 29, Hillside, N. J.
Engraving, etching, marking and printing machines, tools and supplies
(See advertisement on page 68)

Premier Crystal Labratories, Inc., 79 Seventh Ave. New York 11, N. Y.
Piezo electric quartz and tourmaline crystals, reactance & capacity meters

Presto Recording Corp., Paramus, N. J.
Magnetic tape recorder

Price Electric Corp., Frederick, Md.
Relays

Pritchard & Co., J. F., 908 Grand Ave., Kansas City, Mo.
Instrument air dryers
(See advertisement on page 43)

Process Controls Co., 2 East End Ave., New York 21, N. Y.
Designers and builders of electrical, mechanical and electronic controls for automatic equipment and processes

Process & Instruments, 60 Greenpoint Ave., Brooklyn 22, N. Y.
Scientific Instruments

Production Instrument Co., 710 W. Jackson Blvd., Chicago 6, Ill.
Electric & mechanical counting, timing & recording devices & actuating switches

Proportioneers, Inc., 345 Harris Ave., Providence, R..I
Automatic controlling & proportioning equipment

Pyle National Co., 1334 N. Kostner Ave. Chicago 51, Ill.
Connectors

Pyramid Instrument Corp., 49 Howard St., New York 13, N. Y.
Electrical instruments, pyrometers

Pyrometer Instrument Co., Inc., Bergenfield 4, N. J.
Pyrometers for various purposes
(See advertisement on page 109)

Pyrometer Service Co., 228 River Rd., Arlington, N. J.
Pyrometer tubes, thermocouples

R

Racine & Co., Jules, 20 West 47th St., New York 19, N. Y.
Stop watches

Radex Corp., 2076 Elston Ave., Chicago 14, Ill.
Electrical testers

Radiation Counter Labs., 1844 W. 21 St., Chicago 8, Ill.
Geiger-Muller counters, radium detectors

Radioactive Products, Inc., 443 W. Congress St., Detroit 26, Mich.
Radiation survey instruments, electrical and testing instruments

Radio City Products, Inc., 152 W. 25th St., New York 7, N. Y.
Electrical & radio testing instruments & accessories

Radio Frequency Laboratories Inc., Boonton, N. J.
Electronic equipment

Radio Receptor Co., Inc., 84 N. 9th St., Brooklyn 11, N. Y.
Radio test instruments, remote control systems

Rahm Instruments, Inc., 12 W. Broadway, New York 7, N. Y.
Electroenciphalographs; oscillographs
(See advertisement on page 143)

Ranco, Inc., 601 West Fifth Ave., Columbus 1, Ohio
Refrigeration controls

Rapidesign, Inc., 111-BS Orange St., Glendale, Calif.

Rascher & Betzold, Inc., 730 N. Franklin St., Chicago 10, Ill.
Laboratory supplies

Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Cathode ray tubes

Rattray & Co., Inc., George, 92-32 Union Hall St., Jamaica 5, N. Y.
Voltage-dividing resistors

Rauland-Borg Corp., 3523 W. Addison St., Chicago 18 Ill.
Amplifiers, audio-frequency equipment, microphones

Rawson Electrical Instrument Co., 112 Potter St., Cambridge, Mass.
Dynamometers, wattmeters, milliameters & voltmeters. Also ultra-sensitive meters both for A.C. & D.C., fluxmters, electrostatic voltmeters, Thermocouples in vacuum earth current meters, cable testers, millisecond timers
(See advertisement on page 152)

Raytheon Mfg. Co., 190 Willow St., Waltham 54, Mass.
Automatic & manually controlled rectifiers for all communication, industrial or laboratory applications

RCA Division, Radio Corporation of America, Camden, N. J.
Radio & electronic equipment for all purposes including laboratory & industrial apparatus

R. C. Scientific Instrument Co., 335 Culver Blvd., Playa del Ray, Calif.
Radiation counters

Redington Co. F. B., 112 S. Sangamon St., Chicago 7, Ill.
Counters: production, revolution, stroke

Redmond Co., Inc., Owasso, Mich.
Fractional horsepower motors

Reed Research, Inc., 1048 Potomic Ave. N.W., Washington 7, D. C.
Computers, oscillographs, analyzers

Reeder & Co., Charles M., 171 Victor Ave., Detroit 3, Mich.

Reeves Hoffman Corp., 321 Cherry St., Carlisle, Pa
Piezoelectric and quartz crystals

Reeves Instrument Corp. 215 E. 91 St., New York, N. Y.
Computers

Refinery Supply Co., 621 East Fourth St., Tulsa 3, Okla.
Gas testing instruments & specialties for oil & gas industry; & laboratory supplies

Refrigeration Systems, Inc., 646 W. Washington Blvd., Chicago 6, Ill.
Temperature and humidity cabinets, cloud-and-pour oil testers

Reiner Electronics Co., 152 W. 25th St., New York 1, N. Y.
Electronic testing equipment

Reliance Gauge Column Co., 5902 Carnegie Ave. Cleveland 3, Ohio
Steam specialties

Reliance Instrument Co., 3938 W. Roosevelt Road, Chicago 24, Ill.
Electrical indicating instruments

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.
Remote reading flow meters, complete line of power plant & industrial instruments for the measurement of flow, level pressure, draft, temperature & CO_2. Automatic boiler controls, regulators, valves and desuperheaters
(See advertisements on pages 55, 74, 92, 115, 142, 149)

Research Control Instrument Co., 8211 E. 7 St., Tulsa, Okla.
Automatic and manual controllers, valves, components

Resistance Products Co., 714 Race St., Harrisburg, Pa.
Resistors

Resistors, Inc., 5226 West 26 St., Chicago 50, Ill.
Resistors adjustable, variable & wire wound

Revere Corporation of America, P. O. Box 304, Wallingford, Conn.
Thermocouples for liquids, air, metal, hot gases, thermocouple wire, hardnesses and leads. Pitot tubes (shielded and unshielded). Engine & Flight test recording accessories

Rex Rheostat Co., 3 Foxhurst Rd., Baldwin L.I., N.Y.
Protected and unprotected slide-contact rheostats & adjustable, wire wound resistors
(See advertisement on page 120)

Reynolds Gas Regulator Co., Anderson, Ind.
Automatic valves & regulators

Rhoades Metaline Co., Inc., R. W., 50-17 Fifth St., Long Island City 1, N. Y.
Rubber stoppers

Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford 6, Conn.
Time switches

Richards Co., Inc., Arklay S., 52 Winchester St., Newton Highlands 61, Mass.
Thermocouples, lead wire & protection tubes
(See advertisement on page 134)

Richardson-Allen Corp., 116-15 Fifteenth Ave., College Point, L. I., N. Y.
Timers and time switches

Richardson Scale Co., Clifton, N. J.
Automatic weighing machinery

Riehle Testing Machine Division, American Machine & Metals Inc., East Moline, Ill.
Testing machines & testing instruments for tension, compression, bending, torsion, shear, hardness, wear

Rieker Instrument Co., 1919 Fairmount Ave., Philadelphia 30 Pa.
Scientific instruments

Rimat Machine Tool Co., 1117 Air Way, Glendale 1, Calif.
Micrometers

Ritchie & Son, E. S., 112 Cypress St., Brookline 46, Mass.
Marine instruments

Riverbank Laboratories, Geneva, Ill.
Tuning forks

R & M Mfg. Co., Royal Oak Mich.
Machine shop gages

Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield 99, Ohio

Robertson & Co., John H., 4153 W. Belmont Ave., Chicago 41, Ill.
Scientific glassware, laboratory apparatus

Robinette Co., W. C., 802 Fair Oaks Ave., S. Pasadena, Calif.
Automatic control devices

Robinson Orifice Fitting Co., 2830 Lugo St., Los Angeles 23, Calif.
Orifice fittings & plates

Rochester Mfg. Co., Inc., 100 Rockwood St., Rochester 10, N. Y.
Pressure & liquid level indicators & thermometers
(See advertisement on page 135)

Rockwell Co., Stanley P., 296 Homestead Ave., Hartford 5, Conn.
Dilatometers

Rockwell Co., W. S., 264 Eliot St., Fairfield, Conn.
Butterfly control valves
(See advertisement on page 146)

Rockwell Engineering Co., 4063 N. New Jersey St., Indianapolis 5, Ind.
Special instruments

Rockwell Mfg. Co., 400 Lexington Ave., Pittsburgh, Pa.
Fluid meters
(See advertisement on page 35)

Roemer Drug Co., 606 N. Broadway, Milwaukee 2, Wis.
Laboratory supply house

Roller-Smith Corp., 1000 Eighth Ave., Bethlehem, Pa.
Instruments (indicating & graphic) air & oil circuit breakers, relays, switchboards, precision balances, transformers, instrument & control switches
(See advertisement on page 48)

Rollin Co., 2070 N. Fair Oaks Ave., Pasadena 3, Calif.
Electronic test equipment

Rosen Engineering Products, Inc. Raymond, 32nd & Walnut Sts., Philadelphia 4, Pa.
Telemetering

Rotron Div., Jenkes Knitting Machine Co., 180 Weeden St., Pawtucket, R. I.
Air-operated switches

R-S Products Corp., 4523 Germantown Ave., Philadelphia 44, Pa.
Butterfly valves & heat treating furnaces

Rubicon Co., Ridge Ave. at 35th St., Philadelphia 32, Pa.
Precision electrical instruments: potentiometers, galvanometers, bridges resistance standards, for standardization, research, calibration of meters, production testing, & educational applacitions. Photoelectric colorimeters, transmission dynamometers & other special apparatus

Rudolph & Sons, O. C., P. O. Box 446, Caldwell, N. J.
Optical instruments

Ruehfel Co., Inc., George, 107-20 101 Ave., Richmond Hill, L. I., N. Y.
Laboratory instruments & apparatus

Rupp & Bowman Co., 315 Superior St., Toledo 3, Ohio
Laboratory supplies

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- ASSEMBLIES

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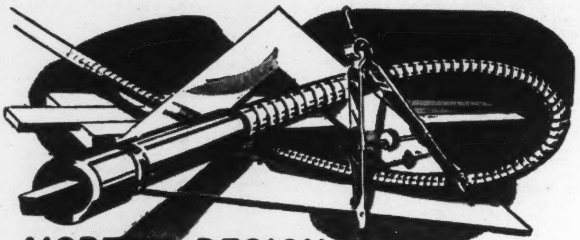

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Ruska Instrument Corp., 4607 Montrose Blvd., Houston 6, Texas
Geophysical instruments

Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.
Calibrating equipment for electrical and electronic instruments, radar simulators

Rutherford Instrument Co., P. O. Box 7406, Washington 4, D. C.
Polygraph

Rutishauser Corp., 490 S. Fair Oaks Ave., Pasadena 2, Calif.
Military and research instruments, engine indicators, oscilloscope cameras

Ruttco Mfg. Co., 105-20 Metropolitan Ave., Forest Hills N. Y.

Ryan Tool & Engineering Co., 19159 John R. St., Detroit 3, Mich.
Height gages, fixtures, special machinery.

S

Saart, Kraemer & Hanscom, Inc., 1 Washington Park, Providence 5, R.I.
Machine shop gages

Sampsel Time Control, Inc., Spring Valley, Ill.
Combustion control equipment

Sampson Chemical & Pigment Corp., 2830 W. Lake St., Chicago 12, Ill.
Phosphorescent and fluorescent coatings
(See advertisement on page 38)

Sanborn Co., 39 Osborne St., Cambridge, Mass.
Electronic instruments
(See advertisement on page 112)

Sangamo Electric Company, 1022 Converge Ave., Springfield, Ill.
Electric meters of all types; also instrument transformers, time switches & radio condensers

Sarco Company, Inc., 350 Fifth Ave., New York 1, N. Y.
Temperature regulators

Sargent & Co., 4647 Foster Ave., Chicago 30, Ill.
Laboratory supplies & chemicals

Saxl Instrument Co., Harvard, Mass.
Tension and torque measuring instruments

Schaar & Co., 754 W. Lexington St., Chicago 7, Ill
Laboratory supplies

Schade Valve Mfg. Co., 2527 N. Bodine St., Philadelphia 33 Pa.
Automatic valves

Schaefer Bros., Co., 1059 W. 11th St., Chicago 7 Ill.
Rheostats

Schaevitz Engr., Crescent Blvd. at Drexel Ave., Camden, N. J.
Accelerometers, extensometers position indicators, remote metering equipment

Schaffer Poidometer Co., 2828 Smallman St., Pittsburgh 22, Pa.
Scales

Schauer Mfg. Co., 2060 Reading Rd., Cincinnati 2, Ohio
Battery chargers, battery eliminators and rectifiers

Scherr Co., Inc., George 200 Lafayette St., New York 12, N. Y.
Optical measuring and inspection equipment

Schneider-Cogswell, Inc., 1849 Halstead St., Chicago 14, Ill.
Precision lenses and prisms
(See advertisement on page 98)

Schultheis Corp., E.W., 812-814 Wyckoff Ave., Brooklyn 27, N. Y.
Thermometers and hydrometers

Schutte & Koerting Co., Cornwells Heights, Bucks County, Pa.
Rotameters

Schwien Engineering Co., 5736 W. Washington Blvd., Los Angeles, Calif.
Aircraft instruments & pressure control instruments

S & C Electric Co., 4435 Ravenswood Ave., Chicago 40, Ill.
High voltage testers, voltage detectors

Scientific Apparatus Co., 4 Landscape Ave., Yonkers 5, N. Y.
Laboratory apparatus

Scientific Equipment Co., 11801 W. Olympic Blvd., Los Angeles, Calif.
Flame photometer

Scientific Glass Apparatus Co., Inc., 100 Lakewood Ave., Bloomfield, N. J.
Glass apparatus & interchangeable ground glass joints

Scientific Instrument Co., 1041 Second St., Detroit 26, Mich.
Industrial & laboratory thermometers; hydrometers; special laboratory apparatus

Scientific Supplies Co., 12 Jackson St., Seattle 4, Wash.

Scott, Inc., Hermon Hosmer, 385 Putnam Ave., Cambridge, Mass.
Electronic instruments

Scott Testers, Inc., 101 Blackstone St., Providence, R. I.
Testing machines

Seedburo Equipment Co., 618 W. Jackson Blvd., Chicago 6, Ill.
Moisture-testers, ovens, scales, thermometers
(See advertisement on page 93)

Seederer-Kohlbusch, Inc., 27-29 S. Van Brunt St., Englewood, N. J.
Analytical balances & weights

Seely Instrument Co. Inc., 377 4th St., Nigara Falls, N. Y.
Controllers & valves

Sell Electric Co., H. H., 3240 Dakota Ave., Minneapolis 16, Minn.
Phase sequence indicators

Sendur Mfg. Co., 3225 N. Sheffield St., Chicago 13, Ill.
Electrical instruments

Sensitive Research Instrument Co., 9-11 Elm Ave., Mt. Vernon, N. Y.
Electrical instruments measuring quantities or values of small current or voltage

Serdex, Inc., 91 Cambridge St., Boston 14, Mass.
Meteorological instruments

Service Recorder Co., 1375 Euclid Ave., Cleveland. Ohio
Vehicle recorders
(See advertisement on page 139)

Servo Corp. of America, 2020 Jericho Tpke., New Hyde Park, N. Y.
Servomechanisms, computers, automatic control equipment and aircraft instruments

Servomechanisms Inc., Post & Stewart Ave., Westbury, N. Y.
Computers, amplifiers, servomotors

Servo-Tek Products Co. Inc., 4 Godwin Ave., Paterson, N. J.
Motion, position and speed recorders

Seth Thomas Clock Co., see Thomas, Seth

Shallcross Controls, Inc., 2217 N. 31 St., Milwaukee 8, Wis.
Furnace controls

Shallcross Manufacturing Co., 10 Jackson Ave., Collingdale, Penna.
Rotary Selector Sitches with solid silver contacts, accurate instrument resistors 0.1% — 5%, decade resistances & standards, bridges, telephone transmission test sets, resistance thermometers, bonding testers & special instruments for electrical measurements

Shand & Jurs Co., 917 Carlton St., Berkeley, Calif.
Liquid level gages

Shawmut Engg. Co., 195 Freeport St., Boston 22, Mass.
Abrasion testers

Sheffield Corp., Box 893, Dayton 1, Ohio
Machine shop gages

Shelby Instrument Co., 321 West 7 St., Long Beach 2, Calif.
Electrical instruments

Sheldon & Co., E. H., Muskegon, Mich.
Laboratory furniture

Shepard Labs., 430 Morris Ave., Summit, N. J.
Automatic exposure controllers, relays, ordnance instruments

Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn 6, N. Y.
Electrical testing equipment

Shore Instrument & Mfg. Co., Van Wyck & Carll St., Jamaica 2, N. Y.
Scleroscope hardness testers
(See advertisement on page 131)

Shurite Meters, 61 Hamilton St., New Haven 8, Conn.
Electrical panel & portable instruments
(See advertisement on page 44)

Sickles Co., F. W., Springfield 2, Mass.
Electrical products

Sigma Instruments Inc., 170 Pearl St., South Braintree, Mass.
Relays

Signal Electric Mfg. Co., Menominee, Mich.
Fractional horsepower motors

Signal Indicator Co., 894 Broadway, New York 3, N. Y.
Dial lights

Simplex Time Recorder Co., Sanborn St., Gardner, Mass.
Time recording clocks

Simplex Valve & Meter Co., 68th & Upland Sts., Philadelphia 42, Pa.
Flow controls, meters, gages, proportioning & ratio control equipment

Simpson Electric Co., 5216 Kinzie St., Austin Station, Chicago 44, Ill.
Electrical instruments
(See advertisement on page 152)

Simpson Optical Mfg., 3200 W. Carroll Ave., Chicago 24, Ill
Lenses, prisms, optical flats & complete optical systems
(See advertisement on page 99)

Sinclair Collins Valve Co. 454 Morgan Ave., Akron, Ohio
Automatic controllers and control valves

Size Control Company, 2500 Washington Blvd., Chicago 12, Ill.
Machine shop & special gages, measuring wires

Sjostrom Co., John E., 1711 N. Tenth St., Philadelphia 22, Pa.
Laboratory furniture

Skaneateles Manufacturing Co., Inc., 122 Dickerson St., Syracuse 2, N. Y.
Vacuum gages

Skyway Precision Tool Co., 3217 Casitas Ave., Los Angeles 26, Calif.
Torque testers

Slocomb Co., J. T., 35 Oxford St., Providence 5, R. I.
Micrometer calipers

Small Motors, Inc., 2076 Elston Ave., Chicago 14, Ill.
Universal fractional horsepower motors, dynamotors, shaded pole motors & generators

Smith Control & Instrument Corp., 1329 Highland Ave., Needham 92, Mass.
Thermostats

Smith Corp., A. O., 5743 Smithway, Los Angeles 22, Calif.
Gasoline and oil meters
(See advertisement on page 79)

Sodemann Heat & Power Co., 2300 Delmar Blvd., St. Louis 3, Mo.
Air conditioned moist cabinet

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.
Transformers, automatic voltage adjusters

Soreng Mfg. Corp., 9555 Eden Ave., Schiller Park, Ill.
Solenoids and switches
(See advertisement on page 123)

Sorensen & Co., Inc., 375 Fairchild Ave., Stamford, Conn.
Chokes, current regulators, voltage regulators, transformers

Sorvall, Ivan, 210 5th Ave., New York 10, N. Y.
Variable transformers

Sound Apparatus Co., Sterling, N. J.
Sound measuring equipment

South Bend Lathe Works, 303 E. Madison St., South Bend, Ind.
Precision lathes

Southern Desk Co., Hickory, N. C.
Laboratory furniture

South Specialty Engineering, see Specialty Eng. & Mfg. Co.

Southwestern Industrial Electronic Co., 2831 Post Oak Road, Houston 19, Texas
Geophysical instruments, industrial controls, electronic development

Sparling, R. W., 945 N. Main St., Los Angeles 54, Calif.
Liquid meters

Special Instruments Lab. Inc., 1003 Highland Ave., Knoxville, Tenn.
Radioactivity and geophysical instruments

Specialized Instruments Corp., 601 O'Neil Ave., Belmont, Calif.
Ultra-speed centrifuges

Specialties Inc., Skunks Misery Rd., Syosset, L. I., N. Y.
Computers, airbourne instruments and cameras, air dehydrators

Specialty Battery Co., 212 East Washington Ave., Madison 3, Wis.
Dry batteries
(See advertisement on page 49)

Specialty Engineering and Mfg. Co., 108 E. Dedham St., Boston, Mass.
Specialists in precision engineering and light manufacturing

Specialty Glass Co., 536 Lake Shore Drive, Chicago 11, Ill.
Laboratory glassware

Speedometer Electric Co., 690 Van Ness Ave., San Francisco, Calif.
Survey footmeter

Speidel & Co., Inc., Chas. W., 614 Baltimore Ave., Fernwood, Pa.
Surveying instruments

Spence Engineering Co., Inc., 53 Grant St., Walden N. Y.
Regulating valves

Sperry Gyroscope Co., Inc., Great Neck, N. Y.
Aircraft & marine navigational instruments

Sperry Products, Inc., Shelter Rock Road, Danbury, Conn.
Special railway testers

Sperry-Sun Well Surveying Co., 1600 Walnut St., Philadelphia 3, Pa.
Underground surveying instruments for oil wells

Sprague Electric Co., Marshall St., North Adams, Mass.
Electrical instruments, resistors, capacitors and circuit components

Sprague Engineering & Sales, 1144 W. 135 St., Gardena, Calif.
High-pressure pumps

Sprague Meter Co., 35 South Ave., Bridgeport 4, Conn.
Liquid meters

Sprengnether Instrument Co., W. F., 4567 Swan Ave., St. Louis 10, Mo.
Scientific instruments magnetometers, seismographs
Squires Co., C. E., E. 40th St. & Kelly Ave., Cleveland 3, Ohio.
Feed water regulators & pump governors

Stafford Co., N., 113 53 St., Brooklyn, N. Y.
Nautical, naval & navigation instruments

Standard Arcturus Corp., 54 Clark St., Newark, N. J.
Vacuum tubes

Standard Cabinet Co., 50 Washington St., Carlstadt, N. J.
Test chambers: altitude, temperature, humidity
(See advertisement on page 51)

Standard Concrete Apparatus Co., 1422 Rhode Island Ave., Washington 5, D. C.
Concrete testing equipment

Standard Dayton Corp., P. O. Box 1001, Dayton 1, Ohio
Fractional horsepower motors

Standard Electrical Products Co, 402 E. First St., Dayton 2, Ohio
Relays

Standard Electric Time Co., 89 Logan St., Springfield 2, Mass.
Electric stop clocks, electric time systems, watt hour meter testing equipment, program clocks, laboratory jack panels & small laboratory table service panels
(See advertisement on page 140)

Standard Gage Co., Inc., 70 Parker Ave., Poughkeepsie, N. Y.
Gages for linear measurements

Standard Piezo Co., 127 Cedar St., Carlisle, Pa.
Piezoelectric and quartz crystals

Standard Products, Inc., 650 E. Gilbert St., Wichita 11, Kan.
Aircraft and ground-station instruments, testing apparatus, precision tools

Standard Science Supply Co., 1232 N. Paulina St., Chicago 22, Ill.
Laboratory supplies

Standard Scientific Supply Corp., 34 W. 4 St., New York 12, N. Y.
Laboratory supplies

Standard Thermometer, Inc., 952 Dorchester Ave., Boston, Mass.
Mechanical thermometers

Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill.
Transformers

Star Compass Co., 110 Antwerp St., East Milton, Mass.
Compasses

Starrett Co., L. S., Athol, Mass.
Precision tools, dial indicators & steel tapes

States Co., 19, New Park Ave., Hartford 6, Conn.
Electricity meter testers

Statham Laboratories, 12401 W. Olympic Blvd., Los Angeles 64, Calif.
Accelerometers, dynamometers, strain gages, flow-meters, pressure indicators, tension indicators

Stebar Co., 711 W. Lake St., Minneapolis 8, Minn.
Microscopes

Steel City Testing Machines, Inc., 8843 Livernois Ave., Detroit 4, Mich.
Testing machines

Steinen Mfg. Co., Wm., 45 Bruen St., Newark, N. J.
Precision screw machine products, stampings and assemblies
(See advertisement on page 174)

Sterling Inc., 3738 North Holton, Milwaukee 12, Wisc.
Motor operated valves

Sterling Mfg. Co., 9205 Detroit Ave., Cleveland, Ohio
Battery testers and portable electrical instruments

Stevens-Arnold Co., 22 Elkins St., So. Boston 27, Mass.
Relays, frequency & polarized
(See advertisement on page 53)

Stevens Mfg. Co., Inc., 69 S. Walnut St., Mansfield, Ohio
Controllers, automatic thermostatic, thermostats

Stewart, M. C., Ashburnham, Mass.
Meteorological instruments

Stewart Instrument Co., 6507 Grand River Ave., Detroit 8, Mich.
Production analyzers

Stewart Mfg. Corp., F. W., 4311 Ravenswood Ave., Chicago 13, Ill.
Remote control equipment
(See advertisement on page 174)

Stewart-Warner Corp., 1826 Diversey Parkway, Chicago 14, Ill.
Tachometers and pressure gages

Sticht Co., Inc., Herman H., 27 Park Pl., New York 7, N. Y.
Electrical instruments
(See advertisements on pages 126, 127)

Stocker & Yale, P. O. Box 8, Marblehead, Mass.
Optical instruments

Stoelting, C. H., 424 N. Homan Ave., Chicago 24, Ill.
Laboratory supplies

Stokes Machine Company, F. J., 5820 Tabor Road, Philadelphia, Pa.
Special process machinery; pressure & vacuum gages; pellet presses; high vacuum pumps; McLeod vacuum gages; automatic water stills

Streeter-Amet Company, 4101 Ravenswood, Chicago 13, Ill.
Automatic measuring, weighing & counting machines
(See advertisement on page 139)

Stromberg Time Corp., 109 Lafayette St., New York 13, N. Y.
Timing devices & time clocks

Struthers-Dunn, Inc., 150 N. 13 St., Philadelphia 7, Pa.
Relays, timing devices, electric counters, thermostats

Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Ceramic thermocouple insulators and protection tubes

Sturtevant Co., P. A., Addison, Ill.
Torque measuring equipment

Sub-Zero Products Div., Deepfreeze Distributing Corp., 3928 Reading Rd., Cincinnati 29, Ohio
Temperature and altitude cabinets

Summers Gyroscope Co., 2328 Broadway, Santa Monica, Calif.
Automatic pilots, and gyro servos

Sun Electric Corp., 6323 Avondale Ave, Chicago 31, Ill.
Electrical instruments & engine test equipment

Sun Radio & Electronics Company, 122-124 Duane St., New York 7, N. Y.
Authorized distributors for all major manufacturers of radio parts, tubes, meters, radio test equipment, electronic equipment for industrial use, instruments for laboratory and industrial tst purposes, and electronic components for the construction of such instruments

Sundstrand Machine Tool Co., 2531 11th St., Rockford, Ill.
Balancing machines, pumps, valves

Superior Controls Co., Inc., 1835 S. Bonnie Brae, Los Angeles 6, Calif.
Thermostats, pressure regulators, control valves
(See advertisement on page 137)

Superior Electric Co., 30 Harrison St., Bristol, Conn.
Industrial & laboratory apparatus

Superior Meter Co., Inc., 167 41st Street, Brooklyn, 32, N. Y.
Gas meters & appliances

Superior Tube Co., P. O. Box 191, Norristown, Pa.
Fine tubing
(See advertisement on page 31)

Supreme Instruments Corp., Greenwood, Miss.
Radio testing equipment; tube testers, set testers, analyzers, test oscillators, oscilloscopes & dynamic instruments
Gages

Surface Checking Gage Co., 1937 Taft Ave., Hollywood, 28, Calif.
Surface roughness standards and comparators

Surface Combustion Corp., 2375 Dorr Ave., Toledo 1, O.
Dew Point Recorder

Surty Mfg. Co., Inc., 4141 W. Kinzie St., Chicago 24, Ill.
Magnifiers

Suter, Alfred, 200 Fifth Ave., New York 10, N. Y.
Testing apparatus for textiles and metals

Suverkrop Instruments, Box 463, Bakersfield, Calif.
Drafting & Surveying instruments

Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio
Furnace controllers

Swedish Gage Co. of America, 8900 Alpine Ave., Detroit 4, Mich.
Internal indicators; plug, ring, master disc & special built fixtures

Sylvan Electronic Labs., Broadalbin, N. Y.
Electronic instruments

Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.
Electronic instruments

Synchro-Start Products Inc., 8151 Ridgeway St., Skokie, Ill.
Automatic starting-stopping safety controls for internal combustion engines

T

Taber Instrument Corp., 111 Goundry St., North Tonawanda, N. Y.
Testers for measuring wear & abrasion resistance of paints, electroplate, linoleum, leather, textiles; precision stiffness gages for paper, light metallic sheet & wire

Taco-West Corp., 525 N. Noble St., Chicago 22, Ill.
Special electronic equipment, electronic controls and automatic machinery
(See advertisement on page 63)

Tagliabue Instruments Div., Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Indicating, Recording and Controlling Instruments for Temperature, Pressure, Level, Flow, Humidity; Hydrometers, Chemical Thermometers. Moisture Meters for Grain, Wood, Tobacco and Granular Materials; Potentiometers, Pyrometers and Resistance Thermometers, Non-Indicating, Recording and Controlling Types; Industrial and Dial-Indicating Thermometers.

Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y.
Wind tunnel instruments, panel boards

Tamms Industries Inc., 228 N. LaSalle St., Chicago 1, Ill.
Pyrometers

Taylor & Co., W. A., 7300 York Road, Baltimore 4, Md.
Equipment for pH & chlorine control, control of phosphates in boiler water & for water analysis

Taylor Instrument Cos., 95 Ames St., Rochester 11, N. Y.
Indicating, Recording & Controlling Instruments for Temperature, Humidity, Pressure, Rate of Flow, & Liquid Level
(See advertisement on outside front cover)

Taylor Dynamometer & Machine Co., 528 W. Highland Ave., Milwaukee 3, Wis.
Hydraulic dynamometers, static balancing machines, super-accurate drill presses

Technical Associates, 3730 San Fernando Rd., Glendale 4, Calif.
Geiger-Mueller counter equipment; custom built instruments
(See advertisement on page 97)

Technical Products Co., 158 Madison Ave., Memphis 1, Tenn.
Laboratory supply house

Technicon Co., 215 E. 149 St., New York 51, N. Y.
Laboratory apparatus

Techno Instrument Co., 6666 Lexington Ave., Los Angeles 38, Calif.
Electrical and electronic instruments
(See advertisement on page 177)

Technology Instrument Corp., 531 Main St., Acton, Mass.
Special audio equipment

Tejax Engineering Corp., P. O. Box 1134, Providence 1, R. I.
Dial indicating handwheels, valve position indicators & V-port hand regulating valves

Tektronix, Inc., 712 S.E. Hawthorne Blvd., Portland 14, Ore.
Cathode ray oscilloscopes & video test equipment

Telechron Dept., General Electric Co., 69 Union St., Ashland, Mass.
Timers and fractional horsepower motors

Telecomputing Corp., 133 E. Santa Anita Ave., Burbank, Calif.
Automatic plotters, computers, counters, projectors

Teletronics Laboratory, 352 Maple Ave., Westbury, N. Y.
Custom design and manufacture of electronic and electro-mechanical devices

Television Equipment Corp., 238 William St., New York 38, N. Y.
Oscilloscopes, television cameras
(See advertisement on page 102)

Televiso Products Inc., 7466 Irving Park Rd., Chicago 34, Ill.
Electronic products; custom built equipment

Tempil Corp., 132 West 22 St., New York 11, N. Y.
Thermoscopic paint & thermometer sticks

Tenney Engineering Co., 26 Ave. B., Newark 5, N. J.
Controlled temperature, humidity and altitude test chambers and rooms
(See advertisement on page 52)

Testing Instruments, Inc., 242 Valley St., Dayton 4, Ohio
Electrical testing instruments for automotive equipment

Testing Machines, Inc., 123 West 64 St., New York 23, N. Y.
Physical testing machines

Testrite Instrument Co., 57 E. 11th St., New York 3, N. Y.
Scientific instruments

Thermal Syndicate Ltd., 12 East 46th St., New York 17, N. Y.
Apparatus, laboratory; flats, optical; gas & vapor discharge tubes, mercury; light sources, mercury vapor; light sources; ultra-violet; optical parts

Thermo-Electric Co., 22-02 Raphael St., Fair Lawn, N. J.
Thermocouples for aircraft engines & industrial uses, extension lead wires & harnesses
(See advertisement on page 134)

Thermo Electric Manufacturing Co., 480 W. Locust St., Dubuque, Iowa
Laboratory furnaces
Thermo Instruments Co., Box 336, Belmont, Calif.
Industrial instruments

Thomas Clock Co., Seth, Industrial Sales Dept., Thomaston, Conn.
Household clocks, outdoor & tower clocks, clock movements for industrial purposes, also electric timers

Thomas Co., Arthur, H., West Washington Square, Philadelphia 5, Pa.
Dealers, retail-wholesale-export, in laboratory apparatus & reagents for laboratories of chemistry & biology

Thomas & Skinner Steel Products Co., 1118 E. 23rd St., Indianapolis, Ind.
Permanent magnets

Thompson Balance Co., 802 E. 18 Ave., Denver 5, Colo.
Fine balances & weights

Thompson Clock Co., H. C., Bristol, Conn.
Electric stop clocks & interval timers

Thordarson Elec. Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformers

Thwing-Albert Instrument Co., 5323 Pulaski Ave., Philadelphia 44, Pa.
Pyrometers, paper testing instruments, portable pH meters, general testing instruments & machines

Times Facsimile Corp., 540 West 58 St., New York 19, N. Y.
High Speed recording and communications equipment

Tinsley Laboratories, Inc., 2526 Grove St., Berkeley 4, Calif.
Astronomical instruments, optical instruments
(See advertisement on page 98)

Tobe Deutschmann Corp., Norwood, Mass.
Electrical and electronic instruments

Toledo Scale Co., 1074 Telegraph Rd., Toledo, Ohio
Automatic Scale for weighing, counting, check-weighing, compounding, force-measuring, weight-printing & weight-recording; & special devices for testing, classifying & standardizing

Topflight Tape Co., 116 E. Market St., York, Pa.
Printed pressure-sensitive tape for identification and labeling

Tork Clock Co., Inc., 1 Grove St., Mt. Vernon, N. Y.
Clocks, timers, time controllers

Tracerlab, Inc., 130 High St., Boston, Mass.
Radioactivity detectors, continuous thickness gages, nucleonics instrumentation, isotopes
(See advertisement on page 24)

Transicoil Corp., 107 Grand St., New York 13, N. Y.
Servo motors

Transvision, Inc., 460 North Ave., New Rochelle, N. Y.
Soldering irons

Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.
Airbourne instrumentation

Trenton Transformer Corp., P. O. Box 568, Trenton, N. J.
Instrument, regulating and testing transformers, magnetic components

Trerice Co., H. O., 1420 Lafayette Blvd., W., Detroit 16, Mich.
Industrial instruments

Trimount Instrument Company, 3119-21 West Lake St., Chicago 12, Ill.
Manometers: well type, sliding scale U-tube, fixed scale U-tube, inclined, absolute pressure, & service; gages: draft & mercury pressure; indicating flow meters & tank level indicators
(See advertisement on page 88)

Triner Sales and Service Co., 325 W. Huron St., Chicago 10, Ill.
Scales and service

Trinity Equipment Corp., 472 Westfield Ave., East, Roselle Park, N. J.
Thermocouple wells; thermometer test wells; separable sockets for thermometers; drilled, welded and cast protecting tubes; stainless steel laboratory apparatus; special alloy machine products; deep hole drilling of alloy bars; API-ASME code alloy welding and fabrication
(See advertisement on page 139)

Triplett Electrical Instrument Co., Harmon Avenue, Bluffton, Ohio
Electrical measuring instruments & radio testing equipment. Also instruments for laboratory and industrial test purposes; switches, relays, resistors, shunts
(See advertisement on page 42)

Triumph Mfg. Co., 913 W. Van Buren St., Chicago 7, Ill.
Radio test instruments

Troemner, Henry, 911 Arch St., Philadelphia 7, Pa.
Balances

Turner Electric Co., E. W., 6138-40 N. Beechwood St., Philadelphia 38, Pa.
Thermowells
(See advertisements on pages 101, 138)

U

U C Indicator Co., 624 E. Locust St., Milwaukee 12, Wis.
Liquid level gages

Uehling Instrument Co., 473 Getty Ave., Paterson 3, N. J.
Co_2 recorders, vacuum recorders, absolute pressure recorders, draft recorders, combined pressure & vacuum recorders, liquid level gages, pressure & vacuum gages, inclined draft gages, well-type direct reading manometers, U-tube manometers, absolute pressure gages
(See advertisement on page 78)

Uhrig Co., Joseph F., 4101-03 North 5 St., Philadelphia 40, Pa.
Scientific glassware

Ulanet Co., George, 413-15 Market St., Newark 5, N. J.
Thermostats
(See advertisement on page 140)

Ulmer Co., J. C., 1791 E. 38th St., Cleveland 14, Ohio
Surveying instruments

Ultrasonic Engineering Co., 1613 S. 3 Ave., Maywood, Ill.
Ultrasonic generators and transducers, photoelectric photometers
(See advertisements on pages 82, 103)

Ultra-Violet Products, Inc., 145 Pasadena Ave., South Pasadena, Calif.
Fluorescence and ultra-violet lamps

Unertl Optical Co., John, 3551-3555 East St., Pittsburgh 14, Pa.
Optical instruments
(See advertisement on page 98)

Ungar Electric Tool Co., Inc., 611-15 Ducommun St., Los Angeles 54, Calif.
Electric soldering irons

Uniform Tubes, Level Road, Collegeville 2, Pa.
Precision tubes of all metals
(See advertisement on page 144)

Unimax Switch Corp., 460 West 34 St., New York 1, N. Y.
Switches

United Condenser Corp., 337 E. 139 St., New York 54, N. Y.
Capacitors

United Electric Controls Co., 85 School St., Watertown

United Electronics Co., 42 Spring St., Newark 2, N. J.
Vacuum capacitors and vacuum tubes

United States Blue Print Paper Co., 207 S. Wabash Ave., Chicago 4, Ill.
Surveying instruments

United States Gauge Div., American Machine & Metals, Sellersville, Pa.
Indicating & recording pressure gages
(See advertisement on page 39)

United States Instrument Corp., 409 Broad St., Summit, N. Y.
Voice powered telephone equipment

United States Taximeter Co., Div. of Weisinger Recording Instruments Corp., 503 W. 54th St., New York 19, N. Y.
Speedometers, tachometers, taxi meters

United States Radium Corp., 535 Pearl St., New York 7, N. Y.

Radioactive products, fluorescent materials, screens and dials, standards of radioactivity
72, Mass.

United Transformer Corp., 150 Varick St., New York 13, N. Y.
Transformers

Universal Drafting Machine Co., 7960 Lorain Ave., Cleveland, Ohio
Drafting Machines

ANNOUNCEMENT

Early this year we announced acquisition of the Western Electric MIRRAGRAPH business. We have recently taken over the remainder of the Western Electric industrial instrument line and are now in production on 3-A Analyzers, 4-A Graphic Recorders, 701-A Sound Level Meters, and 731-A Filter Sets. Prices and delivery on request.

We also produce custom-built Multi-Channel Recording and Analyzing Systems and Automatic Transmission Measuring Systems covering a wide range of frequencies, as well as Curve Followers, Graph Readers, and Regulated Power Supply Units to meet particular requirements. Write us concerning your problems.

Licensed under all Western Electric Patents
in the Testing and Measuring Field

Techno Instrument Company
6666 LEXINGTON AVENUE
LOS ANGELES 38, CALIFORNIA
TELEPHONE
GLADSTONE 3304

Universal X-Ray Products, 1140 Western Ave., Chicago 22, Ill.
Barometers, manometers, vacuum gages, X-ray equipment

Univis Lens Company, 401 Leo St., Dayton 1, Ohio
Optical flats, lenses & prisms

V

Vacutron, Inc., 2819 12th St., So., Arlington, Va.
Special vacuum tubes; electronic circuits & industrial control devices

Vacuum Electronics Engg. Co., 756 Third Ave., Brooklyn 32, N. Y.
Leak detectors

Valpey Crystals, 1244 Highland St., Holliston, Mass.
Quartz crystals for frequency control

Valvair Corp., 454 Morgan Ave., Akron 11, Ohio
Control valves

Valve Pilot Corp., 230 Park Ave., New York 17, N. Y.
Locomotive speed indicator & recorder and locomotive speed & cut-off indicator & recorder

Valverde Labs., 252 Lafayette St., New York 12, N. Y.
Thermal controls

Van Dyke Instruments, Inc., 1927 First Ave., St. Petersburg, Fla.
Accelerometers, remote-metering equipment, resistors

Van Keuren Co., 176 Waltham St., Watertown, Mass.
Optical comparators & flats

Van Wagner Co., 89-04 113 St., Richmond Hill 18, N. Y.
Inspection devices

Vapor Recovery Systems Co., Box 231, Compton, Calif.
Liquid level gages, manometers, remote metering equipment and control valves
(See advertisement on page 77)

Varian Associates, 99 Washington St., San Carlos, Calif.
Klystrons; nuclear resonance spectrometers; traveling-wave tubes; amplifiers; fluxmeters; electronic components

Varo Mfg. Co., Box 638, Garland, Texas
Electronic instruments

V & E Manufacturing Co., 789 S. Arroyo Parkway, Pasadena, Calif.
Drafting machines; drafting room instruments
(See advertisement on page 66)

Vectron Inc., 235 High St., Waltham, Mass.
Optical and electronic instruments, automatic control systems; aircraft instruments

Veeder-Root, Inc., 28 Sargent St., Hartford 2, Conn.
Electrically operated counting devices, a.c. and d.c.

Vibration Specialty Co., 1536 Vine St., Philadelphia, Pa.
Vibration and acceleration indicating and recording instruments

Vickers Electric Div., Vickers Inc., 1815 Locust St. St. Louis 3, Mo.
Rectifiers and photoelectric cells

Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.
Pumps & valving devices for control of power in oil-hydraulic systems

Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio
Electrometers, spectrometers, vacuum tubes

Victory Engineering Corp., 744 Broad St., Newark, N. J.
Analyzing, detecting and automatic control instruments

Viking Instruments Inc., East Haddam, Conn.
Tachometers

Vinco Corp., 9111 Schaefer Highway, Detroit 28, Mich.
Special gages

Visco-Meter Corp., 315 Grote St., Buffalo 7, N. Y.
Viscosimeter

Voland & Sons, Inc., New Rochelle, N. Y.
Analytical balances & weights
Communication measuring instruments

W

Wabash Metal Products Co., Hydraulics Div., 1569 Morris St., Wabash, Ind.
Laboratory presses

Wagner & Son, Carl H., 1944 N. Albany Ave., Chicago 47, Ill.
Thermometers

Walker & Co., Geo. T., 324 Fifth Ave., South, Minneapolis 15, Minn.
Laboratory supplies

Walker-Jamieson, Inc., 311 S. Western Ave., Chicago 12, Ill.
Radio & electronic supplies

Walkirt Co., 5808 Marilyn Ave., Culver City, Calif.
Counters; monitors; testers; scalers

Wallace & Tiernan Products, Inc., I Main St., Belleville 9, N. J.
Chlorine control & chemical feed devices, meteorological instruments
(See advertisements on pages 45, 74, 79, 89, 147)

Walser Automatic Timer Corp., 420 Lexington Ave., New York 17, N. Y.
Timers

Waltham Watch Co., Waltham, Mass.
Stop watches

Ward Leonard Electric Co., 115 Mac Questen Parkway South, Mount Vernon, N. Y.
Resistors, rheostats, relays, motor starters, speed controllers, voltage regulators, electric control devices

Warner & Swasey Co., 5701 Carnegie Ave., Cleveland 3, Ohio
Telescopes

Warren-Knight Co., 136 N. 12th St., Philadelphia 7, Pa.
Surveying instruments & equipment

Warrick Co., Charles F., 1964 West 11 Mile Rd., Berkley, Mich.
Scientific cameras
(See advertisement on page 61)

Warrick, Frederick P., 1960 Graefield St., Birmingham, Mich.
Relays & auxiliary equipment for level controls

Water Leak Detector Co., 114 N. Third St., Columbus 15, Ohio
Water leak detectors

Water Level Controls Div., Healy-Ruff Co., 2255 University Ave., St. Paul 4, Minn.
Liquid level controls

Waterman Engineering Co., 721 Custer Ave., Evanston, Ill.
Automatic flow controllers

Waterman Products Co., Inc., 2445 Emerald St., Philadelphia 25, Pa.
Portable oscillographs
(See advertisement on page 32)

Weatherhead Co., 300 East 131 St., Cleveland 8, Ohio
Pneumatic and hydraulic hose, cocks and fittings

Webber Gage Co., 12904 Triskett Rd., Cleveland 11, Ohio
Gage blocks

Weber Bros., Metal Works, 108 N. Jefferson St., Chicago 6, Ill.
Laboratory apparatus

Weber & Co., F., 1220 Buttonwood St., Philadelphia 23, Pa.
Mathematical & surveying instruments

Webster Instrument Co., 11856 Mississippi Ave., Los Angeles 25, Calif.
Hardness testers, especially for non-ferrous alloys

Weiler, Paul G., 95 Broad St., New York 4, N. Y.
Resistance thermometers

Weksler Thermometer Corp., 52-56 West Houston St., New York 12, N. Y.
Thermometers, hydrometers, psychrometers
(See advertisement on page 136)

Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Electrical instruments, vacuum pumps & items for science laboratories
(See advertisement on page 147)

West Coast Electronics Co., 1601 S. Burlington St., Los Angeles 6, Calif.

West & Dodge Thread Gauge Co., Inc., 6 Power House St., South Boston, Mass.
Screw thread gages

Westberg Mfg. Co., 6535 N. Olmsted Ave., Chicago 31, Ill.
Automotive service instruments, flowmeters, tachometers
(See advertisement on page 124)

Western Radiation Lab., 1107 W. 24 St., Los Angeles 7, Calif.
Radioactivity detecting and measuring instruments; meg-megohmmeters; electron tubes

Westinghouse Electric Corp., 306 4th Ave., P. O. Box 1017, Pittsburgh 30, Pa.
Switchboard, panel & portable measuring instruments, aircraft instruments, recorders, industrial & radio test set equipment.

Westinghouse X-Ray Co. Inc., 2519 Wilkins Ave., Baltimore 3, Md.
Industrial X-Ray equipment

Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Switchboard, panel & portable measuring instruments, Industrial & radio test equipment.
Light measuring instruments and photographic exposure meters. Also dial type industrial temperature gages, control relays and aircraft instruments.
(See advertisement on page 7)

Wheaton Co., T. C. Millville, N. J.
Glassware

Wheatstone Corp., 2436 Reading Rd., Cincinnati 2, Ohio
Thermocouples & pyrometer tubes

Wheelco Instruments Co., 847 W. Harrison St., Chicago, Ill.
Temperature, indicating, recording & control instruments, temperature limit & shut-off device; automatic combustion safeguards
(See advertisements on pages 56, 58, 110)

White Co., Inc., David, 315 W. Court St., Milwaukee 12, Wis.
Surveying instruments

White-Rodgers Electric Co., 1209 Cass Ave., St. Louis 6, Mo.
Furnace controls

Wiancko Engr. Co., 2670 N. Fair Oaks Ave., Altadena, Calif.
Airborne and ground station instruments; fire-control instruments; test stands and devices

Wilcolator Co., 1001 Newark Ave., Elizabeth 8, N. J.
Thermostats

Wilder Inc., R. S., 26 Bedford St., Waltham, Mass.
Microprojector

Wilkening Mfg. Co., 1998 S. 71st St., Philadelphia 42, Pa.
Piston ring gages

Wilkens-Anderson Co., 4525 W. Division St., Chicago 51, Ill.
Laboratory supplies

Will Corp., 39 Russell St., Rochester 3, N. Y.
Laboratory supplies & apparatus

Williams Apparatus Co., Inc., Herald Bldg., Watertown, N. Y.
Pulp & paper testing equipment & flue gas analysis apparatus

Williams, Brown & Earle, Inc., 918 Chesnut St., Philadelphia 7, Pa.
Laboratory supplies

Williams Gauge Co. 1620 Pennsylvania Ave., Pittsburgh 12, Pa.
Water level gages

Willson Products, Inc., Reading, Penna.
Anemometers

Wilmotte, Inc., Raymond M., 1469 Church St., N. W., Washington, D. C.
Electronic gaging instruments

Wilson & Co., G. C., 2 N. Passaic Ave., Chatham, N. J.
Remote-control and remote-metering equipment

Wilson Mechanical Instrument Co., Inc., 230 Park Ave., New York 17, N. Y.
Hardness testers

Winchester Electronics Co., 6 E. 46th St., New York 17, N. Y.
Connectors, plugs, clips, posts, jacks

Winslow Co., Inc., 9 Liberty St., Newark 5, N. J.
Ignition hardness test sets, aircraft engine instruments, thermocouples & instrument accessories, tachometers, vacuum gages, radio & telegraph keys, molded rubber cord sets, megohmeters, Wheatstone bridges

Wollensak Optical Co., 880 Hudson Ave., Rochester 5, N. Y.
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Wood Counterlab, N., 5646 Harper Ave., Chicago 37, Ill.
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Woods "Lab. Apparatus", F. W., 140-6 Warden St., Pittsburgh 20, Pa.
Biological laboratory supplies

Woods Hole Oceanographic Inst., Woods Hole, Mass.
Oceanographic instruments

Woodworth Co., N. A., 1300 East 9 Mile Rd., Detroit, Mich.
Gages for physical measurements

Worley Jewel Co., John, Waltham, Mass
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Worner Electronic Devices, Rankin, Ill.
Photoelectric products

Worthington Pump & Machinery Corp., Harrison, N. J.
Liquid meters and instrument air compressors

Wroble Engineering Co., 1067 Davis Terrace, Schenectady 3, N. Y.
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Wyland, George C., Center St., Ramsey, N. J.
X-Ray tubes & cameras

Y

Yardeny Engineering Co., 105-107 Chambers St., New York 1, N. Y.
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Yarnall-Waring Company, 102 E. Mermaid Lane, Chestnut Hill, Philadelphia 18, Pa.
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Yellow Springs Instrument Co., Inc., Box 211, Yellow Springs, Ohio
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Yonkers Lab. Supply Co., 252 Hawthorne Ave., Yonkers 5, N. Y.
Laboratory supplies

York Ice Machinery Corp., York, Pa.
High altitude test & calibration chambers

Z

Zeiss, Inc., Carl 485 Fifth Ave., New York 17, N. Y.
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(See advertisement on page 93)

Zenith Optical Co., Huntington 19, W. Va.
Microscopes, lenses, optical flats

Zenith Optical Laboratory, 1940 Great Neck Rd., Copiague, L. I., N. Y.
Lenses, mirrors

Zernickow Co., O., 15 Park Row, New York 7, N. Y.
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Maintenance and Servicing of Electrical Instruments *by* JAMES SPENCER, Third Edition, 1951, cloth, 4¾" x 8¼", 256 pages. *Price* $3.00.

Instrumentation for the Process Industries (Proceedings Fifth Annual Symposium on Instrumentation for the Process Industries, School of Engineering, Agricultural and Mechanical College of Texas,) 1951, paper, 8" x 11¼", 56 pages. *Price* $2.50.

A Romance in Research—The Life of C. F. Burgess *by* A. M. MCQUEEN with Technical Appendix *by* O. W. STOREY, 1951, cloth, 6" x 9", 430 pages. *Price* $6.00.

Applications of Industrial pH Controls *by* ALLEN L. CHAPLIN, 1950, cloth, 4½" x 8", 144 pages. *Price* $2.50.

Heat Inertia in Problems of Automatic Control of Temperature *by* VICTOR BROIDA, 1950, paper, 5¼" x 8¼", 61 pages. *Price* $1.00.

Operation and Care of Circular-scale Instruments *by* JAMES SPENCER, 1949, cloth, 4½" x 8", 90 pages. *Price* $1.50.

Scientific and Industrial Glass Blowing and Laboratory Techniques *by* W. E. BARR and VICTOR J. ANHORN, 1949, cloth, 4½" x 8", 388 pages. *Price* $6.00.

Elementary Engineering Electronics *by* ANDREW W. KRAMER, 1945, cloth, 4½" x 8", 340 pages. *Price* $2.00.

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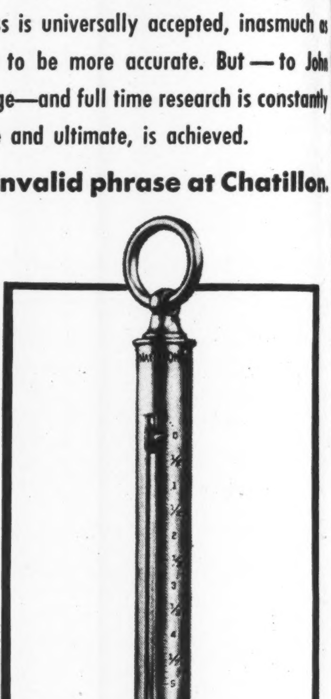

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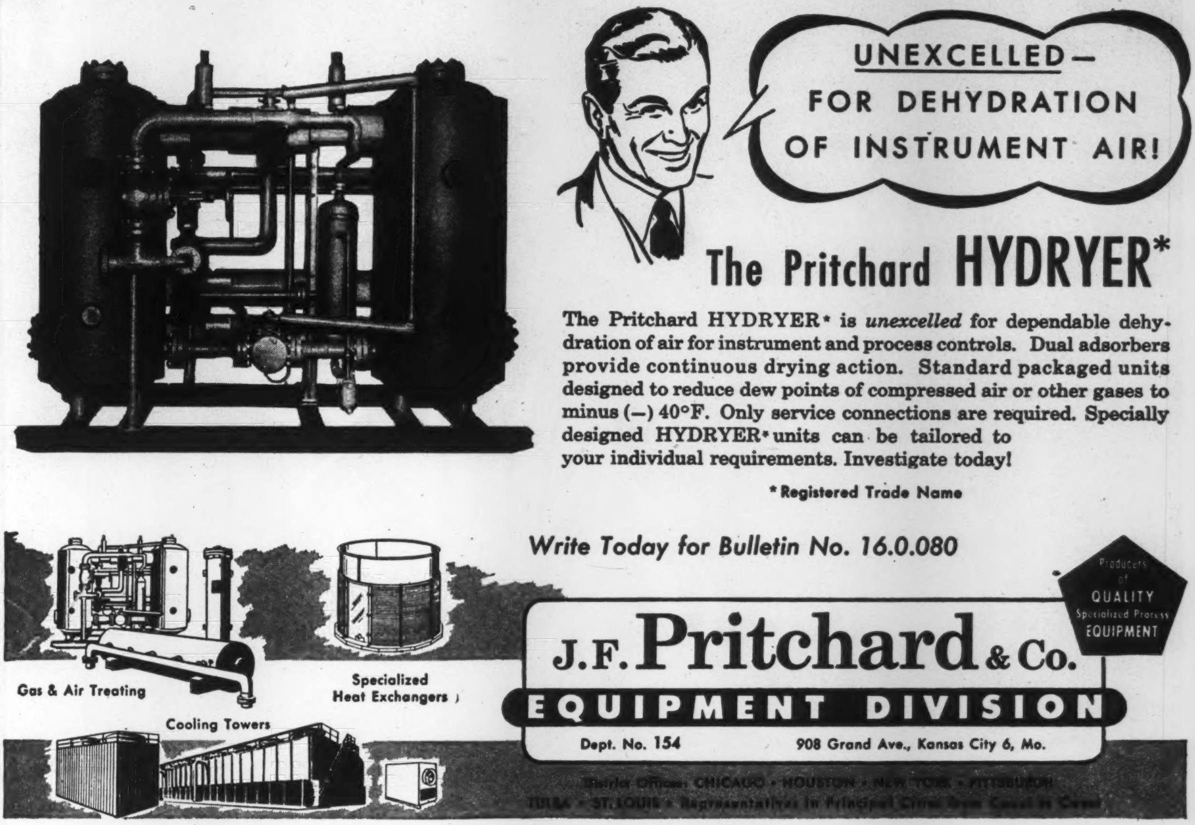

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